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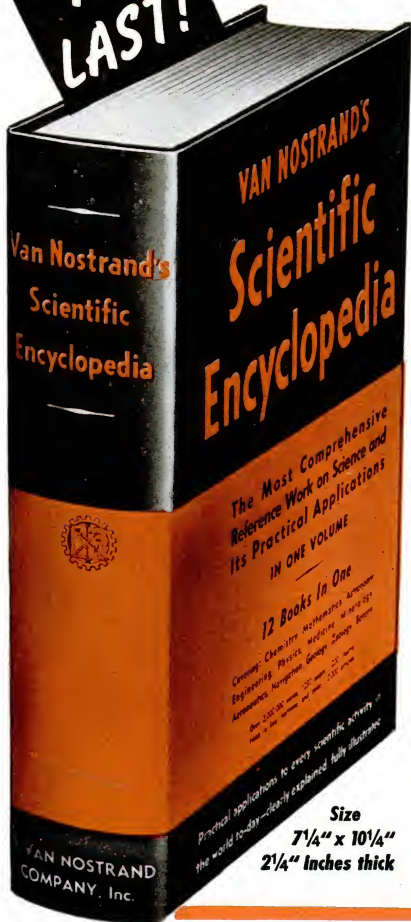
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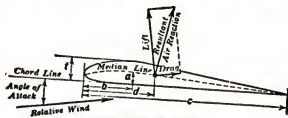
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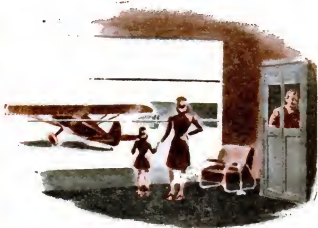
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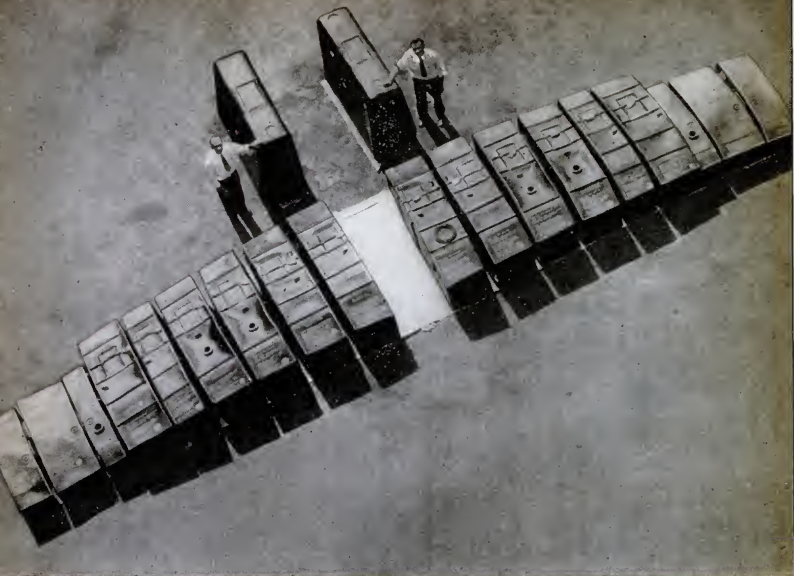


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Airplanes carry gasoline in rubber suitcases

WHEN the crew chief of a Consolidated "Liberator" says, "Fill 'er up," here's what they fill. These gas tanks are arranged exactly as in the plane's wings. They look like this because they were designed to "eat" bullets and get away with it.

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The tank wall is the secret. It's sort of a triple-decker sandwich of synthetic rubbers and fabric. Some of these layers are resilient enough to be pushed *aside* rather than *out* when a bullet goes through. They spring back in place after it's past.

Any hole still left at this point is sealed by the very act of gasoline starting to leak through. For one of the special layers (called the sealant) swells when gasoline touches it, and this instantly closes the puncture.

B. F. Goodrich engineers pioneered many of the developments that led to today's life-saving bullet-sealing fuel tanks. They make oil tanks that seal the same way... gasoline hose, too. Intimate knowledge of synthetic rubbers made all these possible.

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Just behind the battlefield, a telephone system lay dead. The retreating enemy, hoping to return, had not blown it up, but had taken with them its vacuum tubes. To put it back to work, the General ordered 1000 new tubes — spot delivery.

A sample tube was flown back to the United States and brought to Bell Telephone Laboratories. It was of German design, different from any American tube in both dimensions and characteristics. Could it be duplicated soon? The job looked feasible. Within three days, try-out models were on their way to Europe. Three weeks later, Western Electric Company had made and delivered every tube. They were plugged in; vital communications sprang to life.

Vacuum tubes are an old story for Bell Laboratories scientists. Back in 1912 they made the first effective high vacuum tube. Three years later, they demonstrated the practical possibilities of tubes by making the first radio talk across the Atlantic, pointing the way to radio broadcasting. Since then, they have developed and utilized the vacuum tube wherever it promises better telephone communication — there are more than a million in your Bell Telephone System.

Today, Bell Telephone Laboratories is solving many of the toughest tube problems faced by the Armed Forces. When the war is over, it goes back to its regular job — keeping American telephone service the best in the world.



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• This electrical replica of a heater-type pentode was made for use in German telephone repeaters.

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VOL. 147 NO. 1

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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GYROSCOPE. Jap suicide pilots, hurling themselves at our warships, ran into an unexpected obstacle—a top that calculates the lead angle for an antiaircraft gun in the twinkling of an eye. On page 86 Gold Sanders tells how the gyroscope, once only a scientific toy, has become one of the major weapons of modern warfare.

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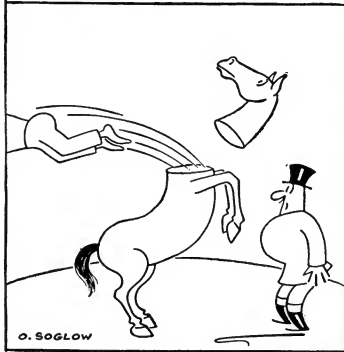
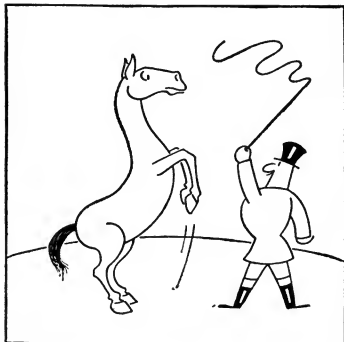
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CHICKENS IN A QUONSET HUT? Well, that's one of the postwar plans we uncovered when we asked readers how they intended to use surplus war goods soon to appear on the market. This contest announced in the March issue brought in many interesting and practical suggestions. You may get a tip that will help you in your work or hobbies.

WHAT DO YOU KNOW about thermostats? These automatic watchmen stand on guard for you in your home and your car. In planes, ships, and factories their mechanical hands throw switches and open or close valves. A B-29 Superfortress has 350 of them. An article by Gold V. Sanders will help you to understand and appreciate their tireless service.

PEACETIME ROLES for the handie-talkie and the walkie-talkie are discussed in a matter-of-fact, down-to-earth story. Large surpluses of these two-way radios may soon be available for civilian use, and the FCC foresees a definite use for the equipment. Read this latest analysis of what we may expect in the way of mobile, two-way communication apparatus.

ICE, always one of the greatest hazards of flight, gains added terrors with the high altitudes and varying climates of global war. How are aircraft designers meeting its challenge? You'll be thrilled by the story of man's long battle with the invisible enemy that drags planes down, and of his latest methods of overcoming it.

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\$600 a Year
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radio work. I
earned money in
radio before grad-
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CHER, Marinette, Wisconsin.

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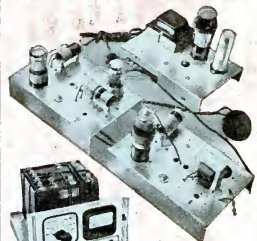
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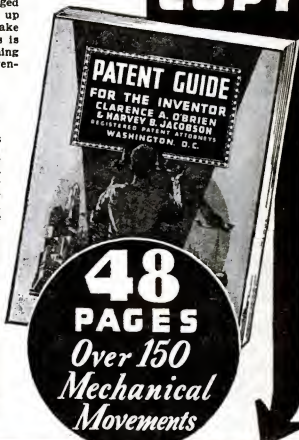
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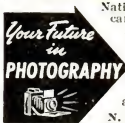
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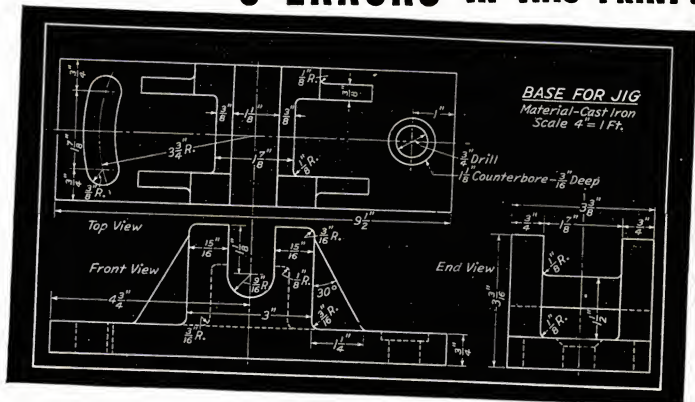
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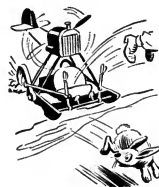
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Readers Say:

Hot-Weather Problem Is How to Brake a Snow Sled

I HAVE built a power snow sled resembling the ones used by the Russians to transport supplies, only this one is built especially for speed and maneuverability to catch coyotes



and wolves with. It has a rear drive and uses an 80-hp. Franklin plane motor with a pusher prop. On good snow it will go about 95 m.p.h., which is fast enough to catch any animal, and then some. Now what I do not have on this outfit is a brake, which I need sometimes to make a quick stop in bad

places. I am wondering if any of your readers or inventors have ever built any of these sleds, and if so, what sort of brakes they put on, if any. There are several of these sleds in this neighborhood, but none has a satisfactory brake for use under all snow conditions.—P. H., Ennis, Mont.

Navy Man Makes Correction on Military Time

IN THE April issue of POPULAR SCIENCE MONTHLY, there was an article about military time in comparison with civilian time. I was glad to see it published, for it will help people understand what their loved ones are talking about when they receive letters in which military time is used. However, there was an error in your illustration, for you had the radio-silence periods marked in the wrong places. In Radioman School at Bainbridge, Md., we were taught that these periods are from 15 to 18 minutes after the hour, and from 45 to 48 minutes after the hour. I wish you would check on this.—R. L. T., S2/c, USNR, Bainbridge, Md.

R. L. T., is right. During these periods, two every hour, the operator must listen for distress signals on 500 kilocycles, which is the frequency universally used for such calls.—Ed.

A Drop of Ink Made This Man Think

ANSWERING A. B. N., of Syracuse, N. Y., indelible ink, from the GI standpoint, is any ink that a GI laundry cannot wash out. Writing inks, even of the "permanent" variety, can be removed from textiles and other materials. They are not waterproof. Indelible inks, under such names as India, laundry-marking, or drafting-room, are theoretically impervious to water.—M. B. O., S1/c (QM), Shoemaker, Calif.

There are various kinds of indelible inks, but one of the most resistant to change is a solution of a salt of silver. This is developed by light or heat, either of which reduces the salt to black silver.—Ed.

Here's an Open Mind on the Subject of Hypnotism

IN THE past year I have noticed that you have had nothing on hypnotism in the Readers Say section of POPULAR SCIENCE. I know there is nothing scientific about it, but is there such a thing as hypnotism, and how does it work?—B. M., Houston, Texas.

It Does Seem a Shame to Throw Them Out

COULD some kind reader tell me some uses for burned-out fluorescent lighting tubes, size 20, 40, and 100 watts?—B. R. L., Newmarket, N. H.

New Use for Silica Gel Suggested by Soldier

WHILE drying my toes at the showers the other day, I remembered an article I had read in P.S.M. called "Silica Gel, the Sand with a Thirst" or something like that. Anyway, since the essential function of foot powders is to dry the feet—especially between the toes in trying to relieve or prevent athlete's foot—wouldn't this super-thirsty silica gel make a good foot-powder base if ground very fine? Or, mixed with some other medicinal factor or factors, the silica gel could do the drying while the other constituents did the germ killing.—Pfc. A. V., New York City.





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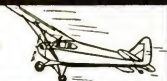


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Readers Say:

How Do You Make an Electric Chair for Flies?

I LIVE on a farm, so we are bothered quite a bit by flies. As I am very much interested in electricity, I wondered if one of your readers could tell me how to make an electric fly killer.—R. I., Loving, N. M.

There was an article in *P. S. M.*, September 1937, entitled "Electrocuting Insects," which answers R. I.'s question.—Ed.

Who Knows a Timesaver for Nailing Up Apples?

WE ARE farmers, and we want to know if any readers of your magazine know of a quick way to nail wooden pine cleats on apple-box ends. The cleats and ends are 7/16-in. thick. A regular nailing machine to do this work costs around \$1,500, and that's too much money for us. We nail around 2,000 boxes each year by hand. That means 4,000 ends, and it is slow work, especially with the labor shortage. Therefore we would appreciate any information that the readers of *POPULAR SCIENCE* can give us. The size of nails used is 1½-in. No. 3 wire.—E. M. B., Tilton, N. H.

Correspondent Has the Answer; Now See What You Can Do

UNTIL now I have not had the time, or maybe the ambition, to write to *Readers Say*, even though I have kept my copies of *P. S. M.* from way back in 1928. I enjoy every single article in your magazine, and like very much the way you can put over an article that, in the first place, doesn't appeal to me but in which I find myself later really interested. I like the brain busters in *Readers Say*, so now I have gotten around to enclosing a drawing of a metal casting. It shows what is both the top and the end view, since both are exactly the same size and shape. Now, what does the front view of the casting look like?—E. B., Vancouver, B. C., Canada.





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Readers Say:

Here's How Old Bicycle Tires Save Paint

So P. M. J., of Charlottesville, Va., would like a use for his old bicycle tires, eh? Well, how about this one? Nail them around the edges of small private wharves to prevent damage and loss of paint on the boats that bump and rub against them. I have tried this on our Mississippi River wharf, and I know it works. But of course they don't have the Mississippi in Virginia!—R. F. L., Davenport, Iowa.

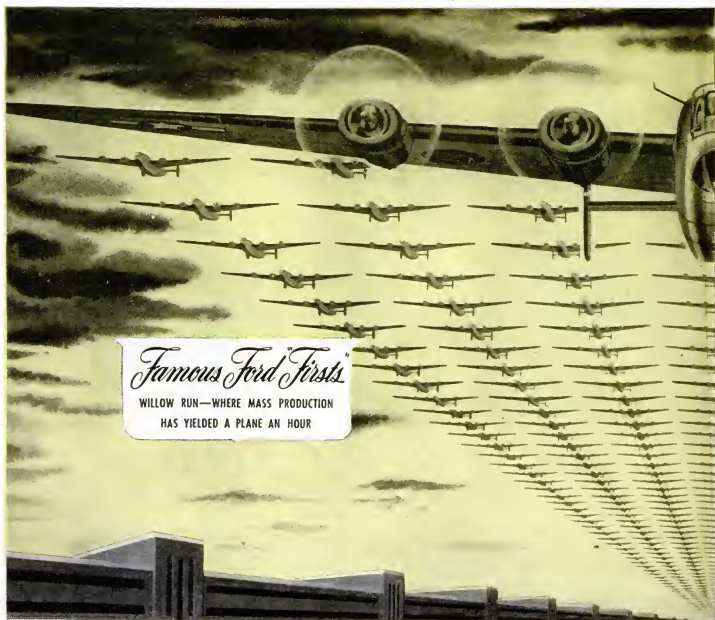


Leakless Sewer-Pipe Joints Are Possible Without Tinning

I WOULD like to add to Pfc. A. V.'s comments on connecting sewer pipes. He suggests the tinning of sewer-pipe joints as a possible aid to making them watertight. This would be both expensive and unnecessary because, for many years, plumbers have been using a special compound that comes in rope form to prevent leaks. This substance is about 1/2 inch thick, and has the packing quality of dentists' filling. No lead is needed, since the preparation contains a certain proportion of that metal. The pipes are joined, oakum is packed in, and then the compound is added and hammered into a solid mass with a calking tool. There is no heating, tinning, or fussing necessary with this method. You don't have to try a connection for leaks, either, because it just won't leak.—R. E., Jamaica, N. Y.

Reasonable Theory to Explain Spiders' Four Pairs of Eyes

BECAUSE I have had some experience with spiders, I was especially interested in the article on them in your January issue. I would like to offer a suggestion with regard to why some spiders have four pairs of eyes, each with a different-sized image and angle of vision. Does it not seem reasonable that, since they have a fixed focus in each pair of eyes, several pairs may be equivalent to a variable-focus lens such as human and animal eyes possess?—J. L. H., Seattle, Wash.



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could be integrated into the assembly system.

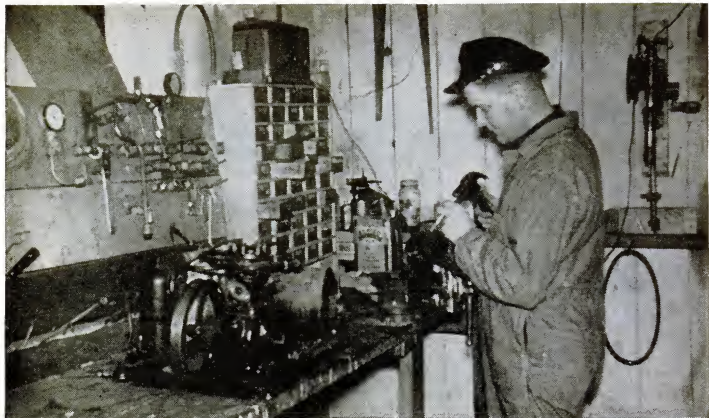
Important shortcuts were developed at every turn. In the case of the center wing section, for example, the construction time of standard aircraft methods was reduced 94%.

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SO IT NEEDS FIXING

By S. T. CHRISTENSEN

the "Fix-it Man"

"**W**ELL, I guess I'm the fellow to see, for I've repaired thousands of refrigerators (home and commercial both), vacuum cleaners, radios, washing machines, irons, fans, lamps, mangles, motors, etc. In fact, many of my customers call me their "electrical appliance doctor." And, "doctoring," I might add has paid me a good substantial income for quite a few years. Funny, in a way, how I got started. Always liked to tinker and by experimenting around I found that most electrical appliances had many things in common. That, regardless of what the appliance was used for, or who the manufacturer was, the basic principles were much the same. From fixing my own appliances to fixing friends' and then for strangers at a fee, seems now to have been but a small step.

What to Charge?

At first, I let the owner decide the charge and, frankly, I was amazed at what I earned per hour. But then, when one figures what initial costs are involved in buying most electrical appliances, one can readily see that spending extra dollars for repairs is well worth while. Before long I was making more in my spare time repairing than from my regular job. The result . . . I went into business for myself. When war came, business boomed, for new appliances were not available.

For a while, repair parts (needed on some jobs) were a little difficult to get. But that

situation seems to have adjusted itself for many repair parts have today the high priority rating of AA2. After all, we must provide for the health and well-being of our civilian population.

The Future Offers

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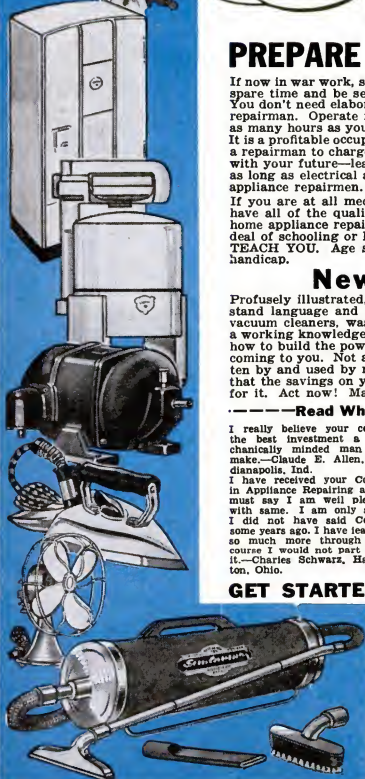
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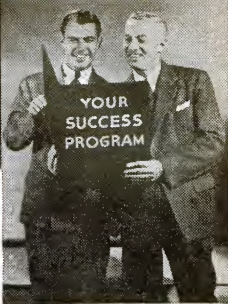
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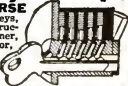


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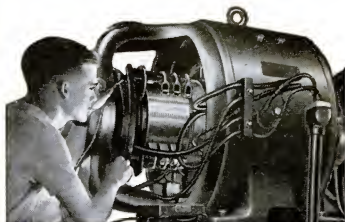
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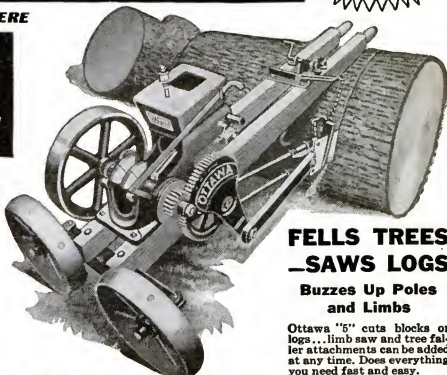
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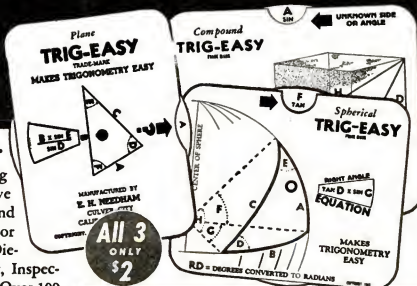
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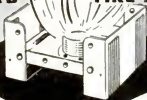
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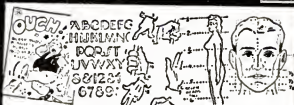
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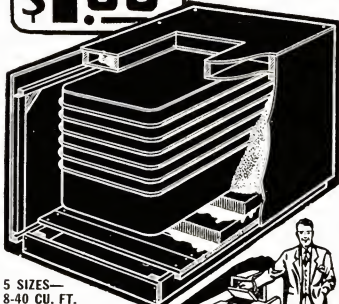
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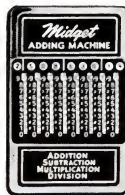
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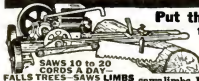
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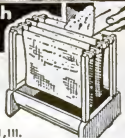
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Over the Himalayan "Hump"—Photo Chinese News Service
—Paul Guillumette

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In the camp at Sagan, Major Orris and his fellow prisoners provided for their needs with homemade equipment described on the following pages. At the right is their symbolic version of AAF wings.



Yankee Ingenuity Licks Prison-Camp Hardships

By VOLTA TORREY

FOR Maj. William Orris and hundreds of other American airmen, being captured by the Germans was like being stranded in an incredibly weird and inadequate world. They were always hungry. They had no tools, and scarcely any material except tin cans. Yet they re-equipped themselves with nearly as many things as a novelty store sells—and they pulled through.

Orris is a tall, bright-eyed pilot who parachuted into the enemy's custody five weeks before D-day and escaped three weeks before VE-day. His B-24 was hit by flak in a bombing run over Toulon. Blinded and nauseated by gasoline fumes, he went out



JULY, 1945

MAJ. WILLIAM ORRIS bailed out into captivity five weeks before D-day, was a prisoner for over 11 months.

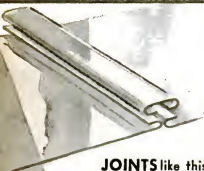
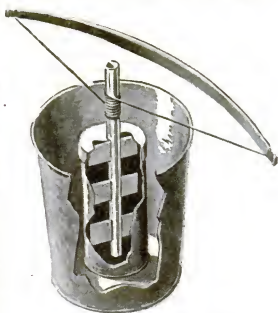


OVENS, like practically everything else the prisoners made for themselves, were fashioned laboriously from old food containers. There were two types, both to be attached to camp heating stoves.



FLATIRONS were tin boxes which were filled with hot coals. Two styles are seen above. The prisoners had such clothes as they were captured in, plus some "booty" garments of various kinds that the Germans seized and issued to them. They did their own washing and pressing.

ICE-CREAM FREEZER was one of the most elaborate kitchen utensils produced by the "kriegies." Tin paddles attached to a tube were rotated by pushing the bow to and fro. Ice cream was enjoyed only in the winter, when ice was plentiful—outdoors. All the tin used came from containers no bigger than coffee cans, cut and joined as shown below.



JOINTS like this were used in patching together the tin taken from food containers.



CUTTING of tin was managed with a knife blade stuck into a floor crack and worked to and fro like a can opener.



SOLDERING. Specks of solder salvaged from can tops were applied with rods made from the handles of jam buckets.

through the bomb bay and lit in a tree beside German headquarters. Looking back, he saw his own plane explode and the rest of his squadron disappear beyond the horizon. "Boy," he says, "I sure felt lonely."

But the Major was luckier than many kriegies (war prisoners of the Nazis). He learned the next morning that his crew was safe. He was questioned cunningly and paraded before French and German civilians. But he was not tortured, and he believes the Luftwaffe's prison camp at Sagan, southeast of Berlin, in which he was confined for the next eight months, was one of the best in Germany.

Even so, the food at this camp was neither good nor sufficient. But at first each man got a Red Cross parcel once a week, and Orris received one of the two dozen packages that his family sent, and about a fifth of the mail addressed to him from America.

With tin cans as shovels, the boys leveled two baseball diamonds for themselves and cleaned out a water tank to swim in. But they soon talked and dreamed more about food than about sports or home or girls. Planning future menus was a favorite occupation, and Orris is carrying out those plans now. While talking to **POPULAR SCIENCE MONTHLY'S** editors, he lunched on a fruit cocktail, two helpings of roast duck with all the

trimmings, and a strawberry shortcake smothered in ice cream.

On a typical day while he was a PW, his breakfast was a cup of poor coffee and two slices of toasted but sour black bread, as thin as Melba toast. Lunch was another slice of bread and a bowl of barley soup as tasty as dishwater. And the day's big meal was half a bowl of potatoes and cabbage with just enough meat to whet a soldier's appetite.

The kriegies were required to punch two holes immediately in every can of food they received from the Red Cross. This was to keep them from saving some for attempts to escape. Another result was that much of the food spoiled, and many men had dysentery.

When a rabbit came through the barbed wire, 70 or 80 of the imprisoned airmen would chase it like dogs. Even three cats that were pets of the prisoners were sacrificed after days of discussion and planning. One man was detailed to stun each cat with a club, another to skin it, and so on. The first man did not hit his cat hard enough, and it got away, but finally the disagreeable job was done, and the men who ate the cat meat said it was good.

The Germans let them have gardens, which they spaded and raked with tin cans. But the soil was miserable, and American officers solemnly followed the horses whenever a wagon entered the camp, waiting for manure. They even built a trap to jolt the cart that carried waste away from the latrine, and salvaged the stuff that spilled out as fertilizer.

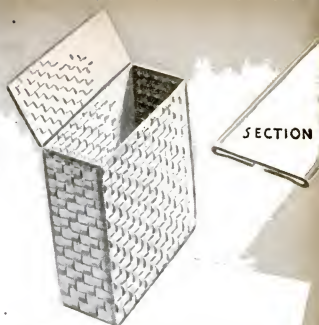
When a kriegie found a nail, he kept it in his watch pocket and took it to bed with him, because it was a precious tool. They had table knives, forks, and spoons, but no pliers, screwdrivers, or hammers. Yet, in addition to doing their own cooking, they had to improvise the utensils.

Their cooking was economical. They saved prune pits, for example, extracted the seeds, and cooked them in margarine to make a dessert. "It tasted like almonds," says Major Orris. Coal was so scarce that they dug up stumps and roots from the prison grounds for fuel, and made "kriegie burners" out of tin cans. These were tiny contraptions that enabled them to get the maximum heat from leaves and twigs.

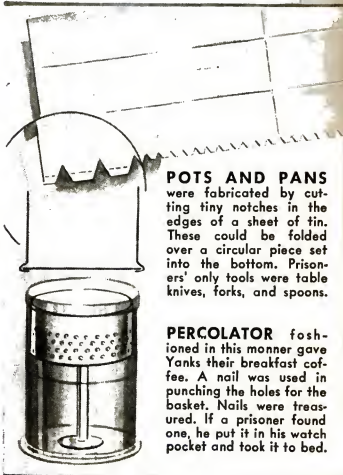
These PW's could not buy anything, but they ran a store where they swapped whatever they happened to have. The storekeepers set point values on everything, and some men soon learned to play the market. When smokes were fairly plentiful, they stocked up with cigarettes, held them until the point value rose, then traded them for soap or whatever else was offered.

Others turned to handicrafts. Some saved metal from the tops of cans, made molds from AAF insignia, and cast new badges for those who had lost the wings from their shirts. A popular variation was an insignie with one wing clipped off and a tiny eight ball hung on a chain in its place.

Some men made knit- *(Continued on page 218)*



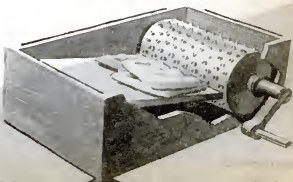
CIGARETTE CASES woven of tin strips were among the fanciest products of kriegie handicraft. Tin was cut into narrow strips, turned over at the edges as seen in the sectional view, and woven.



POTS AND PANS were fabricated by cutting tiny notches in the edges of a sheet of tin. These could be folded over a circular piece set into the bottom. Prisoners' only tools were table knives, forks, and spoons.

PERCOLATOR fashioned in this manner gave Yanks their breakfast coffee. A nail was used in punching the holes for the basket. Nails were treasured. If a prisoner found one, he put it in his watch pocket and took it to bed.

CRACKER MILL provided flour for making pies. Crackers were pressed against a rotating cylinder on which teeth had been raised with a nail. Flour dropped into the bottom section.





HOPPICOPTER is the name given this first really personal flying machine by its inventor, Horace T. Pentecost, of Seattle, Wash. Resembling a helicopter, it is powered by a 20-horsepower, two-cylinder engine that is strapped on the "pilot's" back. He operates the flight stick with his right hand and the throttle with his left. The CAA has licensed the device as an experimental type of aircraft, and the inventor plans flight tests.



"BALL O' FIRE." Auxiliary fuel tanks filled with jellied gasoline (P.S.M., May '45, p. 100) have proved highly effective as incendiary bombs in the Pacific. Carried under

the wings of P-47 fighters like ordinary jettisonable tanks, they explode on striking the ground and splash flaming gobs of gel over a large area.



The gasoline in this P-47 wing tank is the jellied kind. The tail fin (above) makes it fall like a regular fire bomb.

Inside the Superfortress

THE MIGHTY BOEING BOMBER—BATTLESHIP OF THE AIR—COMFORTABLY HOUSES CREW OF 11 IN PRESSURIZED CABINS.



TAIL GUNNER

PRESSURE BULKHEAD

TOP SIGHTING BLISTER

PRESSURIZED TUNNEL

PRESSURE BULKHEAD

BERTHS FOR RELIEF CREW

SIDE SIGHTING BLISTER

SIDE GUNNER

RADIO OPERATOR

ENGINEER

COPLOT

BOMBARDIER

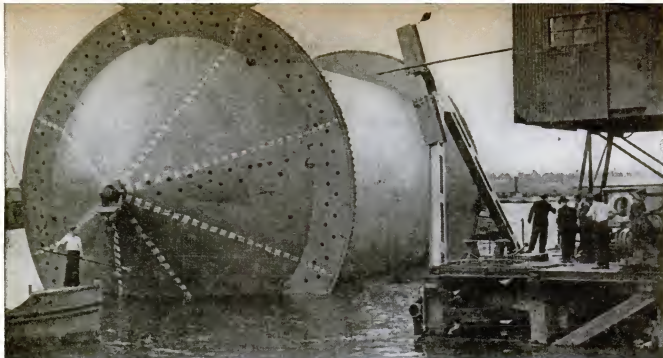
NAVIGATOR

BOMB-BAY DOORS

SUPERCHARGER (TWO PER ENGINE)

PILOT

More than half the crew occupies the B-29's nose section, which is connected to the midsection gunners' compartment by a pressurized tube. Beyond this are quarters containing berths for relief crew. The tail gunner's "office" is located under the rudder. Drawing by Norman Dawn.



"CONUNDRUMS," huge reels on floating docks, were wound with steel pipe welded together into a continuous length of 70 miles. The 1,600-ton loaded spools were then towed across the Channel, as shown at the left, paying out pipe as they went.

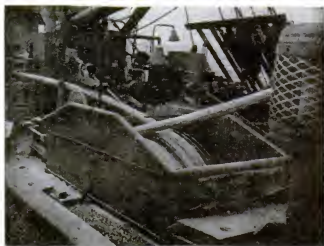


Under-Channel Pipe Lines Fed Our Tanks



LIBERTY SHIPS laid another kind of pipe resembling underwater electric cable. A 10,000-ton vessel could stow 100 miles of pipe in her hold (above). The photo at right shows the flexible cable being paid out over a drum set in a hatch of the S.S. Latimer, one of the two Liberty ships used in the operation. Twelve of the cables laid were of this type; the other eight, of steel.

TWENTY pipe lines laid under the English Channel, 16 of them about 30 and four about 70 miles long, pumped some 120,000,000 gallons of gasoline to the British and American armies between August 12, 1944, and VE-day, it has been revealed. Pumps concealed on the English coast pushed the fuel through the underwater pipes to the French shore, from which high-pressure lines carried it on to the Rhine. Two kinds of pipe were used under the Channel, one of steel, the other resembling underwater electric cable. Both were three inches in diameter and could stand a pressure of 1,200 pounds to the square inch.



Pershing Tank Packs 90-mm. Punch



A 16½-pound projectile from this 90-mm. gun on the Pershing will pierce 14 inches of armor at 300 yards. Firepower also includes two .30 caliber machine guns and one .50 AA gun. (Official U. S. Army photo.)

AMERICA'S new General Pershing, or M-26, is the Joe Louis of tanks. It is neither the biggest nor the heaviest tank of World War II, but has what is needed to outfight any other tank. The function of a tank is to provide firepower, mobility, and crew protection for offensive action, and its value must be judged on this basis.

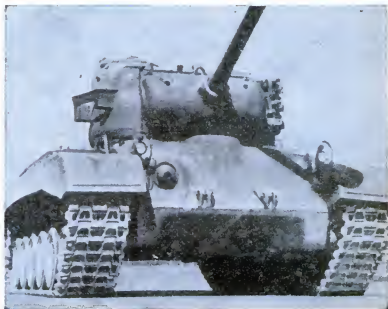
The Germans' 60-ton Tigers and 75-ton Royal Tigers had 88-mm. guns (P.S.M., June '45, p. 68). But the 45-ton Pershing carries a 90-mm. gun, with such high muzzle velocity and armor-penetrating power that this tank has been nicknamed the "Tiger Tamer."

The Pershing is driven by an eight-cylinder, 500-horsepower engine, has a top speed of 25 miles an hour, and can negotiate grades up to 60 percent. Its moving tracks are two feet wide. Torsion-bar suspension makes this monster ride smoother than its predecessors. The fluid drive is similar to that used in automobiles, and the tank is steered with levers. Dual controls make it possible for the assistant driver to

take over its operation promptly if the driver is put out of action.

Its crew of five is protected by front armor and a gunshield four inches thick, and by inch-thick armor in back. The M-26 is 19½ feet long, 11 feet 2 inches wide, and only slightly over nine feet high.

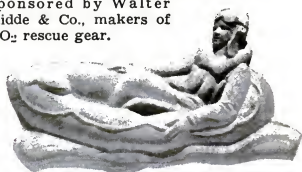
Four-inch-thick armor, sloped for maximum protection for its weight, covers the front of the new M-26. (Signal Corps photo.)





JAP BALLOON BOMB. U. S. Army officers and a G-man examine a bomb that drifted onto the American mainland under a 33-foot paper free balloon. Released in Japan or possibly from submarines, such bombs apparently were designed to start forest fires.

SEA SQUATTER'S PIN will be worn by United Nations airmen who have been forced down at sea. It is the emblem of the Sea Squatters Club sponsored by Walter Kidde & Co., makers of CO₂ rescue gear.



B-29 IN DOGHOUSE. This Superfortress is receiving skin treatment preliminary to conversion into a F-13A super photo-reconnaissance plane at the Continental-Denver Modification Center. The "doghouse" protects workers from the weather. In the winter, such shelters are heated by blowers of the type used for warming plane engines.



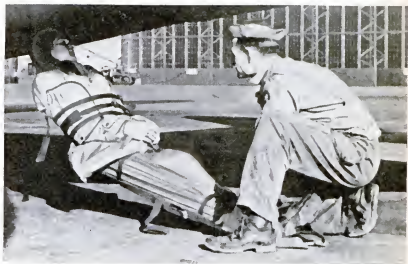
IN AVIATION



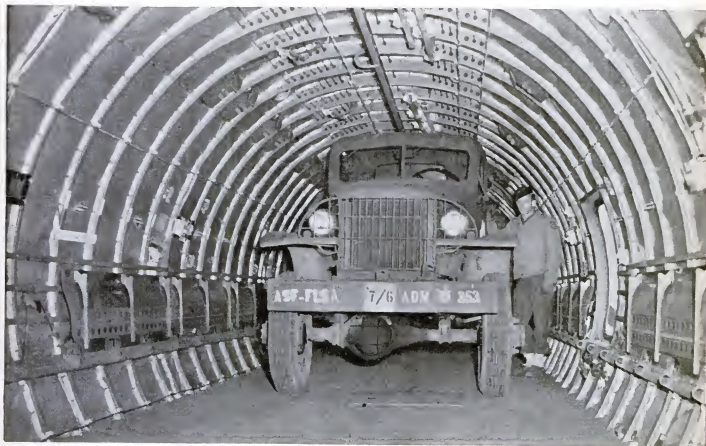
ERNIE PYLE, America's late beloved war correspondent, has a namesake in the form of a B-29 Superfortress. The big plane was

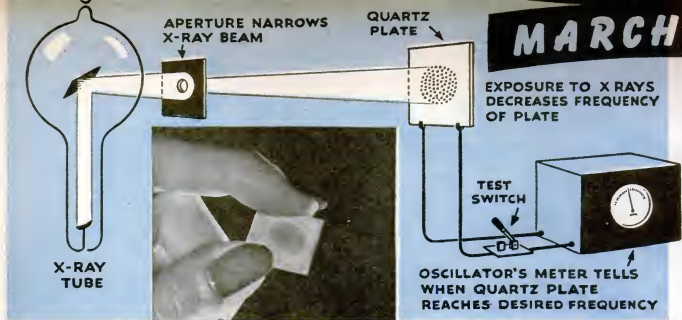
paid for through purchases of War Bonds by employees of the Wichita (Kan.) Division of Boeing Aircraft Co., where it was built.

WRAP-AROUND LITTER of canvas reinforced by hardwood strips enables a wounded man to be removed safely from cramped quarters in a bomber.



INSIDE THE C-97. Below, a 2½-ton Army truck is parked in the upper fuselage section of the cargo version of the B-29. Two such trucks can ride this main deck, with other equipment, while personnel or cargo is carried in two lower compartments.





X RAYS ADJUST FREQUENCY of paper-thin quartz plates, indispensable as control units in high-precision radio transmitters and receivers. The process, of which the general principles are shown in the drawing,

eliminates time-consuming hand grinding and uneven chemical etching. Effect of X rays on crystalline substances was discovered by Dr. Clifford Frondel of the Reeves-Ely Laboratories, New York City.



PEANUT WOOL, a synthetic fiber called ardil, has been developed by the Imperial Chemical Industries, Ltd., after 10 years of experiments. It may be woven with real wool, cotton, and rayon for the manufacture of inexpensive textiles. The synthetic fiber is made from protein from the peanuts after oil for industrial uses has been extracted. David Trail, ICI scientist, says it will be cheaper than pure wool, with all the cold-resisting properties.

PNEUMATIC TOURNIQUET, with a gauge dial to indicate pressure, almost totally eliminates the danger of post-operative gangrene, which frequently develops from use of manual tourniquets. The anesthetist inflates the device as incision is made and

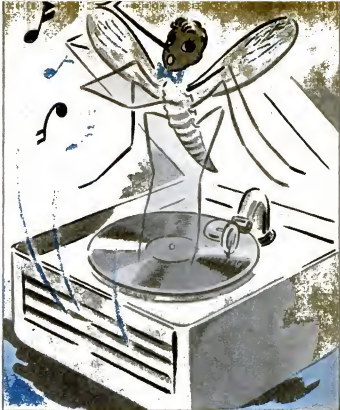
controls pressure throughout the operation (left, below). Tourniquet (right, below) consists of a rubberized fabric tube which is reinforced by a belt of the same material. It was developed by Dr. Harold R. Conn and is produced by Goodyear.



MOSQUITO LOVE SONGS are being "canned" on phonograph records by scientists at the Cornell University Medical School. Mating calls of insect Sinatras and Ginny Simmses may be used to lure disease-bearing pests into traps.

Often only faintly audible to human ears, the insect sounds were greatly amplified for recording. Practice enabled the experimenters to distinguish between the songs of different genera, and between those of males and females. Running true to form, the females' voices are louder and more highly pitched than the males'.

A mosquito will not sing without an audience. Even a male quartet may refuse to sing until a female comes along; then they break out with the mosquito equivalent of "Sweet Adeline."



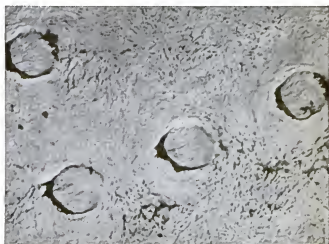
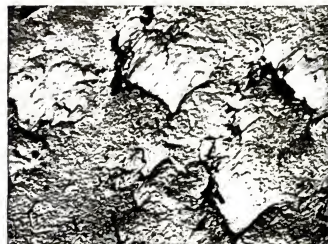
PEA SEEDS from the tomb of King Tut bear fruit! Three kernels given to an American Army officer yielded 1½ pounds of fresh peas.

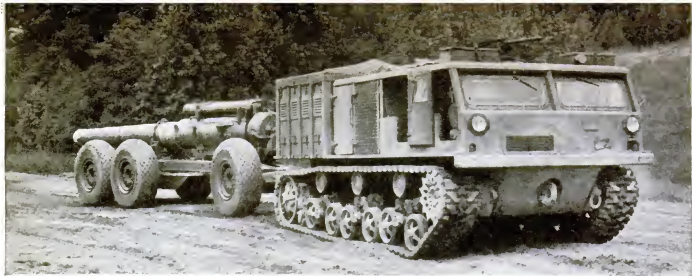
Some of these were sowed, and, while producing a healthy crop, were not attacked by pests which chewed up neighboring plants.

The bug-resistant King Tut peas have a distinctive walnut flavor, and may prove to be more valuable than the jewels found in the tomb.

TEETH HAVE CANALS. Every one of your teeth has about 50 miles of canals. This fact is revealed by the RCA electron microscope, which has a magnification up to 100,000 times. The mountainous-looking area on the left, below, is the enamel sur-

face of a normal human tooth, magnified 5,300 times, disclosing irregularities of structure never before seen. The other picture is a cross-section shot showing canals in the dentine, and openings which appear as huge craters.





↑NEW

Daddy of 'em all is the new American 240-mm. howitzer. This "Black Dragon," hauled in two parts by 38-ton tractors, can race over rough terrain at 21 miles an hour, be emplaced with a truck crane in 1½ hours, and shoot 360-pound shells over 14 miles.

↓OLD

Compared with the new howitzer, the old 240 (below) moved at a snail's pace. It had to be broken down into four sections, carried on solid-tired wagons that were pulled by slow tractors, and could not be emplaced in less than four hours, mostly by handpower.



Biggest Gun on Wheels

By JOHN E. LODGE

CHAMPION of heavyweights—but with the agility of a bantam—that's the new 240-mm. howitzer which blasted the great gaps in the steel and concrete forts of the Siegfried line. Not only is the M-1 the heaviest of all our mobile artillery, but it goes into action in a hurry. All previous performance records in speed of movement and emplacement of big guns have been put in the shade by this product of U. S. Army Ordnance ingenuity. So quickly can this

monster be thrown into action that it is used on targets of opportunity as well as for demolition. That gives an idea of the gigantic stride represented by this weapon.

Mobility is the middle name of the 240-mm. howitzer. It moves in just two parts, drawn by 38-ton tractors, at 21 miles an hour, the 12½-ton barrel riding on one six-wheeled transport wagon and the 20-ton carriage on another. With their 18 x 24 pneumatic tires and high-speed axles, the transport wagons are a far cry from the slow-moving, solid-tired trailers that were

CLAMSHELL bucket on the crane digs the recoil pit. The crew formerly did this job—with shovels.



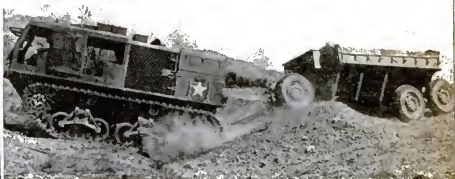
HUGE CARRIAGE is lifted by to be set down over the pit. The carriage was unbuckled in one minute.





The 12½-ton barrel (on left, above) and the 20-ton carriage (right, above) make up the heaviest mobile gun now in use.

Its mobility was limited, its range five miles less, and its rate of fire from two to three times slower than the new gun.



Rough-riding trailers bear the shells to feed the huge M-1. Each carrier hauls 32 rounds, enough for about half an hour.

Gains Speed and Punch

used to carry the old-model howitzers.

When it comes to getting the new gun into action, the methods and means are equally modern. A huge truck-mounted crane digs the recoil pit in a fraction of the time formerly required by men with shovels. The same crane picks up the carriage and the barrel with ease and sets them in place. With this up-to-date equipment, the big howitzer is ready to fire in a little more than an hour. The old one could not be emplaced in less than four hours under

CRANE now picks up the barrel to set it on the carriage. (Right) M-1 is ready for action.





OLD

It took valuable time—hours of it—and plenty of elbow grease to dig a recoil pit for the old howitzer.

the most favorable conditions. It was almost all hand work.

When the new howitzer goes into action, its performance is likewise far superior to that of its predecessor. Its range is 14

Power-driven winches were same help in setting up the old gun, but it was also tug and pull for artillerymen to line up and fix each section in place.

miles, against nine. Its rate of fire is three times as fast, its projectile heavier. The gun itself can be swung in either direction $22\frac{1}{2}$ degrees from center, as against 10 degrees for the old one. The added area of

NEW

Everything is geared to speed in emplacing the mighty M-1. And before each is sent to a battlefield it is put through its paces in this country. The gun shown here was pictured as it was being set up and tested at the Aberdeen Proving Ground in Maryland.



1 Only two pairs of turnbuckles hold the gun's carriage to the transport wagon. These can be loosened quickly to free the carriage.



2 Meantime, each of the four mammoth spades that brace the carriage against recoil is quickly tightened into place. In the field, pit is not plank-lined.



3 Easy does it. Special connections at the center of gravity make the job of lifting the 20-ton carriage a smooth operation. Set a few hooks—it's all!



4 With equal speed the barrel is swung from its wagon by the powerful crane over to the waiting carriage.



5 Then the long tube is maneuvered into the ready-made fittings on the gun carriage and locked in place.



6 The 360-pound projectile is put into the trough that guides it into the breech. A 240-mm. shell is almost $9\frac{1}{2}$ inches in diameter.



GI's then strained to adjust the awkward monster's fittings. In fact, the whole operation was slow motion compared with the crane-operated equipment.

enemy territory brought into range is immense.

About the only similarity between the new and the old guns is the caliber of 240 millimeters, slightly under 9½ inches.

So quickly can this monster be thrown into action that it is used on moving targets as well as for demolition work. And its functional simplicity helps to explain why our men in the field defeated the Germans, who were the tops in artillery for nearly a century. The Yank is the new master in the big-gun field.

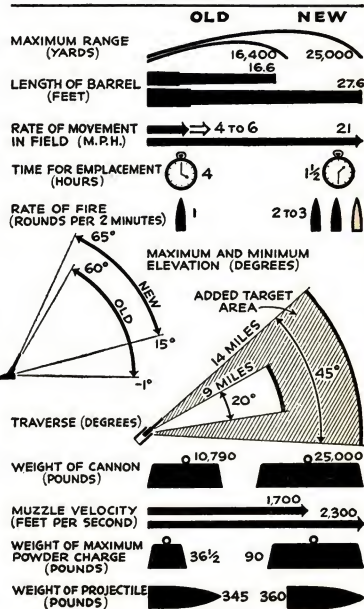


7 (Above) With 90 pounds of powder behind the shell, the breechblock is closed.

8 (Below) A GI works the elevator mechanism. When everything is ready—BOOM!



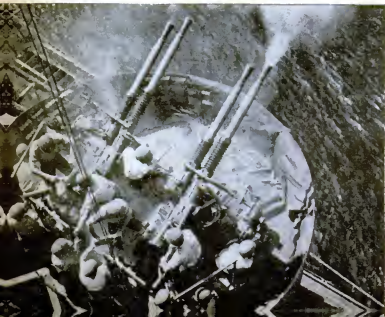
OLD AND NEW 240-mm. HOWITZERS COMPARED





THIS FLAMING RING and fireball were caught out, not by the Bofors guns at lower left, but by one of the ship's 12 six-inch guns. No targets are used for the big guns, the weapons being fired solely to test operation and train gun crews.

PARAVANE DRILL. Seamen launch the fishlike drag which, towed from the bow, cuts loose mines so they can be detonated by rifle fire when they surface.



THE "SHACK." Busiest room on the cruiser is the communications office. Here, amid the clatter of typewriters and sending and receiving instruments,

SHAKEDOWN

HOW SAILORS ON A NEW LIGHT

TO GIVE a new ship and a new crew a chance to size up each other, the Navy packs them off on a three or four-week jaunt known as a shakedown cruise. Neither ship nor crew wastes time giving the other the works. Among other things, the vessel is raced forward and backward, turned "hard over" to see whether her rudder jams, and swung sharply to starboard and port to make sure that her compasses all give the same reading at the same instant. The crew learns to take her rolls and pitches, and to

ANTI-AIRCRAFT. Of the 13 very busy men at lower left, only two are aiming and firing the four 40-mm. Bofors. The rest are kept on the jump just feeding the ammunition to these shell-gulping guns.

SHELL CASES, made of precious brass, are saved far use again. A net snags the five-inchers as they are dropped through holes in the turret floor. The shells are used against both aircraft and ships.





highly trained specialists maintain contact with bases and other ships. By means of intraship phones, the shock also keeps in touch with various parts of the cruiser.



NIGHT FIRING is done to accustom the gun crews to the blinding flash as well as the terrific bark and jolt of the six-inch guns. One bone-jarring test of a shakedown is to let all the starboard or port-side guns go off at the same time.

CRUISE...

CRUISER FIND THEIR SEA LEGS

stand firm when she lets go a mighty salvo of her biggest guns.

These official Navy pictures were taken on a recently commissioned light cruiser. Reliable unofficial sources reveal that she is a 10,000-ton ship of the *Cleveland* class, with a speed of 33 knots. She carries 12 six-inch guns, 12 dual-purpose fives, and a number of 40 and 20-mm. ack-acks. Without her armor, she cost about \$18,000,000. On her shakedown she carried 400 men above her normal 888.

THREE 20-MM.-GUN CREWS (lower right) gong up on a plane-towed target and blow it full of holes. The same kind of target is used for the cruiser's dual-purpose five-inch guns.

IF AN ENEMY SHELL knocks out the communication lines from the range-plotting room, a gun-crew captain can pop his head out of the turret and do his own aiming with these sights.



YOU HAVE A
NASTIER COLD
THAN YOU THINK!

Now **VIRUS*** IS BEING CONQUERED BY MEDICAL SCIENCE

* MAN'S DEADLIEST ENEMY

In one week not long ago, 32,000,000 Americans contracted colds. It has been estimated that colds cost us 800,000,000 man-days of labor a year. Now, at last, we can see this enemy and plan its ultimate defeat.

By JOHN GILMORE

Drawings by the Author

INFLUENZA has defied penicillin, sulfa drugs, and dozens of other new microbe killers—but the thing that causes it can now be seen. So there's really more reason now than ever before to hope that science soon will win its long war against influenza, the common cold, and the many other ailments caused by extremely tiny viruses.

These viruses that are responsible for diseases such as virus pneumonia, infantile paralysis, yellow fever, parrot fever, measles, mumps, and trachoma range in size from only 10 to 280 millimicrons. A millimicron is a millionth of a millimeter, and a

millimeter is about a twenty-fifth of an inch.

Since these minute but deadly enemies of mankind can slip through bacterial filters, they are known as filterable viruses. Since they are beyond the range of even the most powerful optical instruments, they also have been called ultravisible viruses.

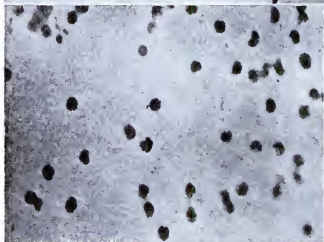
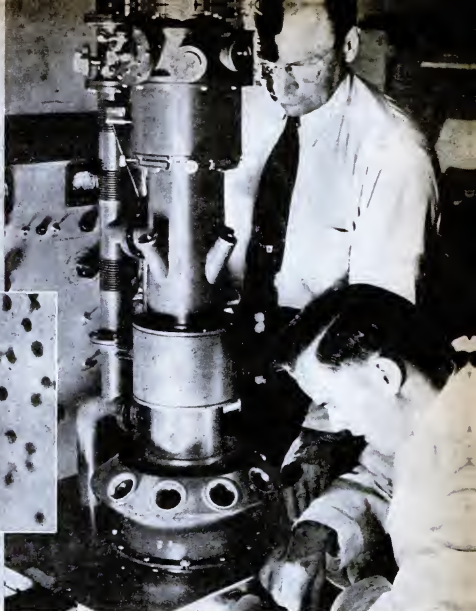
The electron microscope, however, has exposed them. It has made them visible by substituting penetrating electrons for light. A stream of these electrons is focused and directed by electromagnets. The result is extraordinary magnification of the object, an image of which is thrown on a photographic plate or viewing screen somewhat similar to a fluoroscope. While an object can be enlarged only 5,000 times by an optical microscope, it can be enlarged 100,000 times by an electron microscope.

To supplement this mighty microscope's work, two other new machines recently have been invented. One is a device that cuts material to be analyzed into slices only one twentieth as thick as the average human hair. Another is an electron micro-analyzer with which the chemical elements of a particle only a hundredth of an inch in diameter can be identified.

There is no precise definition of virus. Its most important characteristics are its small-

ELECTRON MICROSCOPE GIVES US FIRST VIEW OF INFLUENZA VIRUS

"Ultravisible" viruses, so called because they formerly were beyond the range of even the most powerful available magnifiers, can now be seen with the aid of the electron microscope. At right is the powerful RCA instrument, with Dr. V. K. Zworykin (standing), head of the RCA Electronic Research Laboratory. Below is the first photo ever made of the influenza virus bodies



It was taken at the Duke University School of Medicine. In our reproduction, virus is magnified 27,500 times

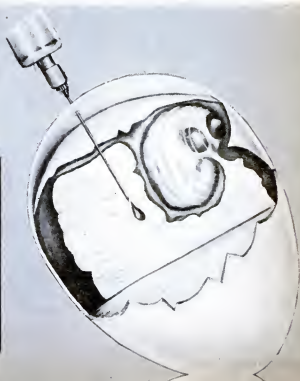
ness, its ability to grow only on living tissue, and its ability to create changes within cells. Some scientists believe that virus is the real missing link between inanimate and animate matter, with properties of both. It is definitely a living entity, because it grows and multiplies, yet a pure crystalline protein that not only contains but is composed of

virus has been obtained for scientific use.

Scientists have been certain about the existence of these filterable disease entities for only about half a century. The common cold was not traced to a virus until a few decades ago. But much progress already has been made and more is anticipated, especially in the development of vaccines to

INJECTION OF CHICK EMBRYO PRODUCES VIRUS, VACCINES

A chicken's egg is an ideal medium for growing virus for laboratory use. Virus is injected into the partly developed embryo as shown below and in the transilluminated specimen at right. In this living culture, the virus develops rapidly and is kept from contamination



WHAT JUST ONE SHOT OF VIRUS CAN DO TO AN EGG

prevent and cure virus diseases.

Research has been accelerated not only by the invention of mightier microscopes but also by the discovery that the developing embryo of a chicken's egg is an ideal growing medium for virus. A great many mediums previously had been tried to assure a plentiful supply of virus for laboratory use. Fertilized eggs now are allowed to develop for several days, then virus is carefully injected, not merely under the shell, but into the embryo itself. In this living culture, the virus develops rapidly and is kept free from contamination by other viruses or bacteria.

Another remarkable discovery is that passing virus from egg to egg over a period of time will change its character and destroy the power of the virus to produce disease. This discovery has made possible the production of antibodies, the mysterious organisms provided by nature to fight diseases. These antibodies are used in vaccines, along with killed or weakened virus, in treatments to make persons immune to a disease.

Dr. Joseph Stokes of Philadelphia has used egg-developed virus to inoculate children against measles, with excellent results.

Russian scientists experimented in 1940 with inhalations of vaporized anti-influenza serum during a flu epidemic, and this idea has been further developed by American scientists. The U. S. Navy, using a specially built tank, has experimented with mass inhalations of serum vapor.

Numerous strains of virus cause influenza. One of them, known as Influenza A, has been isolated by Dr. F. B. Burnet of Australia. Tests with Influenza B on "human guinea pigs," reported last year by Dr. Thomas Francis, Jr., of the University of Michigan School of Public Health, indicated that a single kind of flu may attack the same person twice within four months. Inhalation has yielded more favorable results than any other method of flu prevention tried thus far.

Thanks to the research of Drs. Seeds and Mazer of Texas, virus pneumonia now can be diagnosed with X rays. An X-ray pat-

Light shining through the healthy egg below reveals freelike structure



... but here's an egg simply teeming with virus. Passing virus from egg to egg produces disease-fighting antibodies.



tern of the disease has been identified. Some success also has been achieved in X-ray treatment of virus pneumonia.

The history of smallpox, one of the virus diseases, suggests what may be accomplished when more is known about these micro-organisms. Smallpox is believed to have existed in China in 1700 B.C., and by 1000 A.D. it had spread all over Europe. Before the great Dr. Jenner developed smallpox vaccine, more than 200,000 persons a year died in Europe of this disease. But since then smallpox has steadily declined and is rare now in civilized countries where vaccination is routine health procedure.

In one week recently, 32,000,000 Americans were estimated to have contracted colds. The Los Angeles Health Department says that 800,000,000 man-days of labor are lost annually in this country because of colds. In Detroit, during one week of the all-out war effort, flu kept 15 percent of the workers away from their jobs. But colds and flu are only a couple of the many ways in which the filterable viruses, which science may now be on the verge of conquering, have sabotaged humanity.

What's Good for a Cold? Here Are 10 "Musts"

- 1 Avoid crowds. Viruses are spread by coughing, sneezing, and just breathing.
- 2 When you catch cold, stay home. If possible, go to bed. Rest saves strength.
- 3 Be sure to drink lots of water, hot liquids, and fruit juice.
- 4 Avoid close contact with others. Nothing spreads faster than a cold.
- 5 Always cover your nose and mouth when you cough or sneeze. Germs scatter.
- 6 Eat nourishing food—not too much at a time, but often.
- 7 Take a mild laxative only when necessary. Avoid strong cathartics.
- 8 Don't strain your eyes by reading. A cold weakens your eyes.
- 9 Call a doctor if your cold is very severe, or if you have pain in the ear or chest.
- 10 Stay in bed until your temperature is normal. Stay at home until you are well.



SPRAY ARMOR protects this Coast Guard fireboat and crew from flying sparks, and enables the vessel to attack harbor fires at close range. This newest seagoing fire-fighting apparatus is 40 feet long and as powerful as three fire engines. It was built for duty at Manila and other recaptured Pacific ports.

CARBIDE ARMOR-PIERCING SHELL.

A separate, bullet-shaped core of cemented tungsten carbide, hardest metal made by man, is housed in an aluminum casing and hits with such striking force that it rips through a tank's armor plate at ranges up to 3,000 yards. This shell-within-a-shell (see the five principal parts at the lower

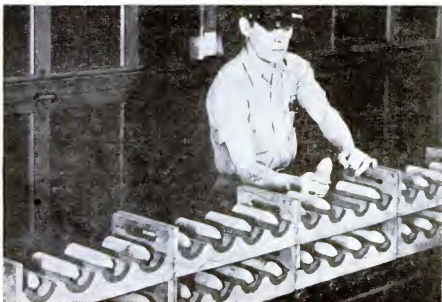
right) is made for tank and antitank guns.

The extreme hardness of the core prevents it from flattening on impact. Its aluminum covering streamlines the projectile and permits a small-diameter core to be fired from a gun of larger bore. After penetration, the carbide core breaks up and scatters fragments in all directions.



The hard and tough tungsten carbide core of this shell penetrates armor with far greater effectiveness than other steel-piercing projectiles. Made by the Carboly Company, these tank-busters have been in combat action for the past year.

RUBBER-SPONGE "BEDS" cradle the delicate carbide cores before they harden into the toughest of metals.



The Little Top That Aims a Gun

How the gyroscope, once just a curious scientific toy, has been harnessed to guide ships and planes and make their fire deadlier.

A TINY, fast-spinning wheel that used to be nothing but a child's toy has been transformed overnight into one of the deadliest of our war weapons. The gyroscope has finally come into its own, and we are making

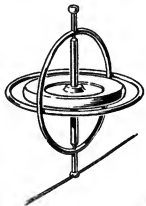
Drawings by STEWART ROUSE

WHAT IS A GYROSCOPE?



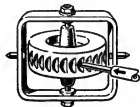
A spinning top is a simple gyroscope. Obeying the natural law of inertia, it always maintains its axis stationary in space.

Put that spinning top in a ring, with bearings at top and bottom, and you have the basis of a gyroscope.



In this familiar gyroscopic toy, a top has been given true balance. This plaything inspired Elmer Sperry's work.

For practical use, continuous rotation is needed. The rotor can be part of an induction motor



... or it can be kept spinning by a jet of air drawn against its notched rim by a vacuum created inside the instrument.

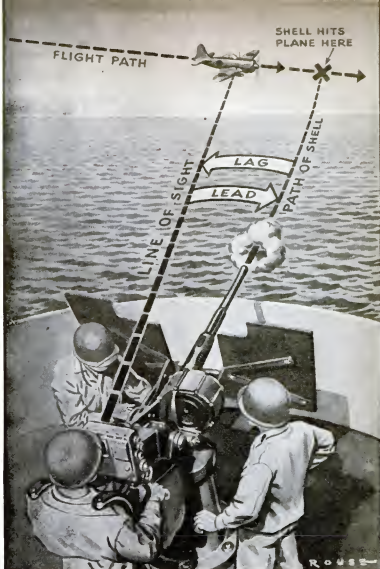
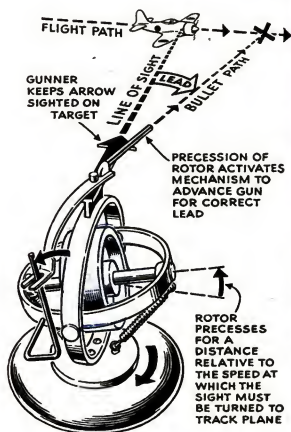
full use of its uncanny power. It virtually saved the battleship from the junk pile by giving us gunsights that could knock down Jap planes before they got close enough to dive-bomb or launch torpedoes. It made the devastating B-29 raids on Japan possible without fighter escort. The Superfortresses can take care of themselves because of two spinning wheels no bigger than a baby's fist that give their guns accuracy never known before.

The turning point in the Pacific war came when U. S. "Battleship X" virtually annihilated a force of attacking Jap planes on October 26, 1942. That was the first major tryout of the new gunsights and the first clear-cut victory of seapower over airpower in many a day. When the reports of that battle came in, it was apparent that something new had been added since Jap planes sent the mighty British warships *Repulse* and *Prince of Wales* to the bottom in a few minutes. The Navy was so thrilled about the new gunsight and attached such importance to it that even the name of the battleship was kept a secret for a long time afterward. Now we know that it was the *South Dakota*, and the Navy has also revealed the fact that its ability to smash attacking planes was due to the gyroscopic sights newly installed on its anti-aircraft guns.

Many thousands of the gunsights have been made since then. They are now in control of practically all American and British naval anti-aircraft guns, and they have shot down Jap planes by the hundreds. That is one reason why our Navy was not afraid to go within range of Japanese land-based planes. The Jap navy was chopped down to near impotence by a succession of defeats. Some of these were administered by our surface ships and some by our planes, but in either case the superior protection of our fleets against attack from the air gave us a mighty advantage. Jap pilots knew it was literally suicide to attack our ships, but they kept trying. Very few lived to try again, although a few got through to inflict damage on light naval units.

American inventive genius has given us these important new weapons, and several

"RATE GYRO" COMPUTES LEAD
for antiaircraft guns. Putting a broke on a gyroscope makes it a "rate gyro," so that the amount of its precession (tilt to resist turning) is determined by the rate at which it is moved from its original plane of rotation. In the model below, the arrow represents line of sight to the target; the rod, direction in which gun barrel is pointed and path of the bullet.



As the gunner follows the target with his sight, the precession of the gyro causes the gun barrel to "lead" the enemy plane. The faster the gun is swung, the greater the precession becomes and the more the barrel leads the sight, so that shell and plane reach the same point simultaneously.

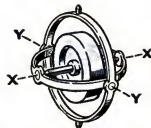
others, by harnessing the peculiar power that scientists have long known to reside in the spinning gyro wheel. The principle of the gyro is a simple one and as old as the world itself. The inertia of a spinning mass is what makes a top stand upright, and this

is the basis of all gyroscope uses. Though scientific men have known this for more than 100 years, they made no practical use of it until early in this century. Their first use was in a weapon of war, the torpedo, as a stabilizing agent. Then, in 1911, after

GIMBAL RINGS ALLOW ROTOR TO SWING FREELY

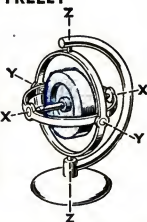


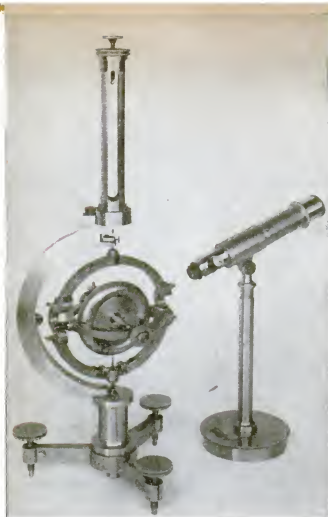
Starting with a well-balanced rotor, an inner ring is provided for its bearings. X-X is the spinning axis.



A second ring is attached by free-turning bearings. In it, the rotor can swing on axis Y-Y, at right angles to axis X-X.

Only a half ring is needed to complete the gimbal mounting. On this third axis, Z-Z, the inner rings turn, enabling rotor to swing in any direction. Ball bearings are used in all axes of the gimbal rings.





FIRST GYROSCOPE to be so called was the instrument built by Leon Foucault, French physicist, in 1852 to prove the rotation of the earth. For rotation, the rotor in its inner gimbal ring was placed on the stand above and cranked to high speed, then transferred to the mounting at left. This is a duplicate owned by Columbia University.



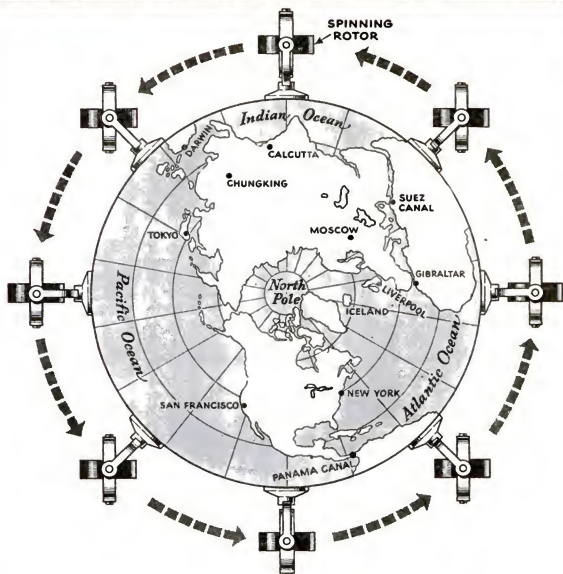
MODERN ROTORS. For practical uses, gyroscope rotors like these are made by the thousands. The smaller ones are of the air-driven type—miniature turbines—employed in aircraft instruments, gunsights, etc. The large one is the 10-inch rotor of the Sperry gyrocompass made for big steamships.

years of labor and discouragement, Elmer Sperry was given a chance by the U. S. Navy to prove that a gyrocompass was a better and more reliable navigating guide than the time-honored magnetic compass. The Navy trials were a triumph for the inventor.

That was the beginning of man's mastery of another natural law. The gyrocompass, of course, is now in use on just about every first-class ship in the world. After that, Sperry went on to invent the stabilizer that takes most of the roll out of ocean-going steamers. Then he put his gyrocompass to work as an automatic ship's pilot. For airplanes he produced the gyro horizon, direction indicator, and other gyroscopic instruments that first made blind flying possible. Harnessing these instruments still more, he made the automatic gyro pilot for planes, now in universal use.

In the First World War, these were the only instruments based on the gyroscopic principle. In this war, the gyroscope rates as one of the most important of all agencies for giving precision and stability to weapons as well as safety to navigators on the sea and in the air. It was the U. S. Navy that gave Elmer Sperry recognition for his years of work on the gyroscope when, in 1911, his gyrocompass was installed in the then new battleship *Delaware*. And it was Sperry's company that came to the Navy's rescue at a critical period of its history by developing

GYRO'S STABILITY IS UNAFFECTED BY EARTH'S ROTATION

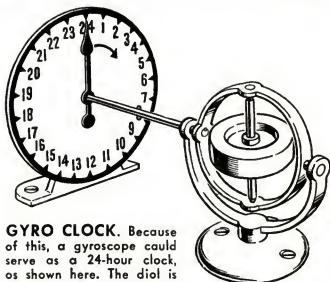


A spinning gyro wheel maintains its original spinning plane regardless of the rotation of the earth. To an observer, it appears to make one complete revolution about its horizontal axis in 24 hours. Actually, it has stayed in the same plane while the earth has turned around.

and building the gyroscopic gunsight. The importance of this one invention to the nation can hardly be exaggerated.

Fortunately for this country—and for the whole civilized world—the Sperry Gyroscope Company was laboring over a gyroscopic gunsight even before the Japs descended upon Pearl Harbor. In 1940, Sperry engineers, in collaboration with Dr. C. Stark Draper, of Massachusetts Institute of Technology, went to work on a Sperry project of applying a “rate gyro” to a computing gunsight for warships. It was highly desirable to create a naval sight based on the gyroscope because of its ability to maintain its position in space in spite of a ship’s roll and pitch. Mechanical computers had no such ability.

The “prescription” for the sight was finally written. The precision demanded in all



GYRO CLOCK. Because of this, a gyroscope could serve as a 24-hour clock, as shown here. The dial is set to the south of the instrument, with the hand attached to an extension of the gyro's horizontal axis. If friction could be overcome, it would be a perfect sidereal clock.

parts was far more exacting than that of the finest watch. Tolerance of some elements had to be as small as one ten-thousandth of an inch to make the gunsight accurate. Months of diligent effort under high pressure brought success. Engineering brains and ingenuity had written another brilliant chapter in the history of American invention.

Almost ridiculously small are the vital parts that give this gunsight its ability to shoot speeding planes out of the air with regularity. The rotors—two to each sight—are two inches in diameter and weigh less than a pound each. They are turned by an air jet shot into slots around the perimeter. At a speed of 10,000 to 11,000 r.p.m., they have the necessary inertia to remain independent of all influences except those deliberately and carefully brought to bear upon them in order to perform the function of

giving the gun a correct lead in front of the moving target.

When a spinning wheel, nicely balanced, is properly hung in gimbal rings, it is entirely independent of all its surroundings—as if it were a thing apart from the earth. Its own inertia is its only law, but that law is absolute. All gyroscopic instruments obtain their peculiar abilities from calculated efforts to make the spinning rotor violate this law, a thing the scientists know it will not do. What the gyro does to preserve its inertia is to “precess,” that is, to move at a 90-degree angle away from a force applied against its axis of rotation. Since this movement can be counted upon absolutely, the inventors employ it to do whatever is desired—to open and close valves, apply and cut off electric current, and so forth.

The type of instrument employed in the gunsight is called a “rate gyro.” That is,

it is a gyro controlled by springs so that the faster it is made to precess, the greater the force it exerts on the springs. In the gunsight, this force is determined by the rate of movement given by the gunner to the gun in following the target. Fast movement gives greater force than slow movement. This force is instantly transmitted to a mechanism that offsets the line of sight from the line of the gun bore so that when the gunner is aiming his sight at the target, the gun is actually pointing ahead of the target by the right amount so that the enemy will fly into the bursting shell. All the gunner has to do is to follow the target steadily with the sight and pull the trigger.

When the B-29's were being designed for the special mission of long-range bombing raids on Japan, it was obvious that they would have to go without fighter escort, so the efficiency of their guns in protecting them from enemy fighters was a matter of greatest concern. Gen-

WHAT IS "PRECESSION?"



The rotor of this gyro is spinning in a vertical plane from front to back.



Try to push the rotor out of its spinning plane. Instead of tipping, it turns to side.



Pressure from the opposite side makes it turn the other way, on its vertical axis.



GRAVITY causes precession if the rotor is not balanced. The weight pulling against the spinning plane causes the gyro to turn as shown.

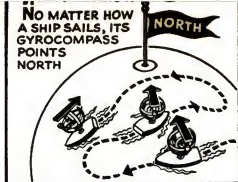
Try the same test with the rotor not spinning. Weight simply pulls the ring downward, as there is no resistance now. Any unbalance in a gyro causes precession.



A TO DEMONSTRATE, WE START WITH A GYROSCOPE AT THE EQUATOR, ITS SPIN AXIS POINTING EAST AND WEST

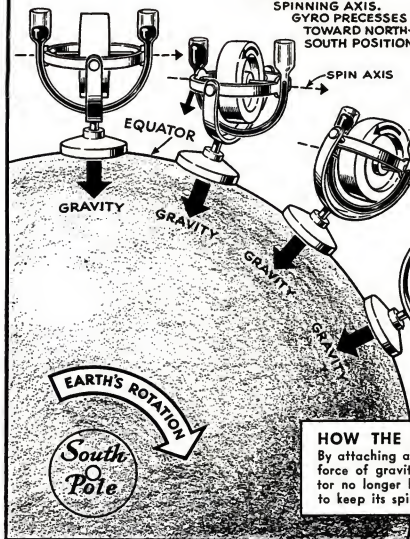
B AS GYRO IS CARRIED EASTWARD, LEVEL OF MERCURY CHANGES. WEST END BECOMES HEAVIER AND EXERTS DOWNWARD PULL ON SPINNING AXIS. GYRO PRECESSES TOWARD NORTH-SOUTH POSITION

NO MATTER HOW A SHIP SAILS, ITS GYROCOMPASS POINTS NORTH



C PRECESSION CONTINUES AS LONG AS MERCURY IS UNBALANCED. SPIN AXIS SEEKS NORTH-SOUTH DIRECTION

D WHEN SPIN AXIS POINTS NORTH AND SOUTH, MERCURY IS BALANCED IN TUBE. GRAVITY NO LONGER AFFECTS GYRO. GYROCOMPASS DOES NOT POINT TO MAGNETIC POLE, BUT ALONG A NORTH-SOUTH MERIDIAN

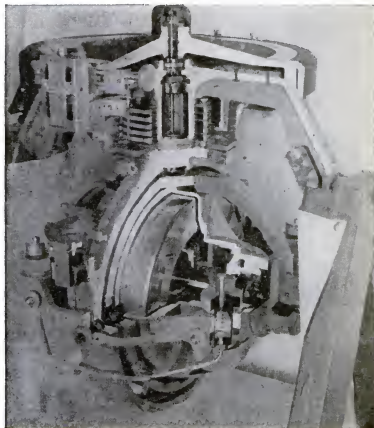


HOW THE GYROCOMPASS OPERATES.

By attaching a mercury tube to the gyroscope, the force of gravity is brought to bear on it. The rotor no longer holds the same plane, but precesses to keep its spinning axis pointing north and south.

SPERRY GYROCOMPASS uses a 10-inch, 55-pound rotor, seen in lower part of cutaway view at right. A slender tube extending around the rotor holds 12 ounces of mercury. Such instruments are now used on most big vessels, including warships.

AN EARLY EXPERIMENT. The familiar gyro toy is used by Elmer Sperry in the old photo below to show how he applied outside forces to make it a compass.



eral Electric was given the vitally important task of designing the controls for these guns. The central gunnery system invented for this special purpose is a combination of electronic, mechanical, and gyroscopic devices that has spelled disaster for the Japs. (P.S.M., Feb. '45, p. 88.) Here again, the prodigious task of computing the speed of an attacking plane relative to that of the bomber was turned over to two tiny spinning rotors, electrically driven in this case. It makes no difference to these magical wheels whether the speed of the fighter must be added to or subtracted from that of the Superfortress; it is done instantly. The gunner sits in a warm, pressurized cabin, follows the target with his sight, and pulls the trigger that may fire one, two, or three sets of guns at once. All calculations are automatic and instantaneous. The guns lead the target by the correct angle at all times.

These are the defensive uses of the gyroscope in war—important enough, surely, but only a fraction of the gyro's contribution to winning this war. Gyros are on the offensive, too—in planes, tanks, ships, submarines, and torpedoes.

When the big bombers—the B-29's and all the lesser ones—arrive over their target area, the whole ship is turned over to the gyroscopes that make the automatic pilot

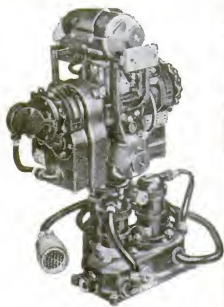
work. The bombing runs must be straight and true, and this is managed by the spinning wheels more accurately than any human hand could do it.

And now the bombing run is on; the vital moment has arrived for which the great machine and its crew have made the perilous journey. Again the gyroscope is called upon to make the bomb hit the mark. The Norden bombsight is put to work—and two more of the spinning wheels are doing their stuff as essential parts of that famous weapon. (P.S.M., June '45, p. 70.)

There has been a lot of controversy about the relative potency of our tanks as against those of the enemy, but in one respect there is no question of our superiority in this department: our tanks can shoot straight on the run. Here, again, the secret is the gyroscope—just one 14-ounce rotor that holds the biggest tank gun on a true horizontal line, no matter how much the tank pitches and rolls over rough terrain. This was an achievement of Westinghouse (P.S.M., Sept. '44, p. 82). General Patton, who ought to know about tanks, gave high praise to the gyrostabilizer in telling how he had been able to beat the larger German tanks for sensational victories. The Germans could shoot straight only when they stopped dead, and then they were sitting ducks for targets,

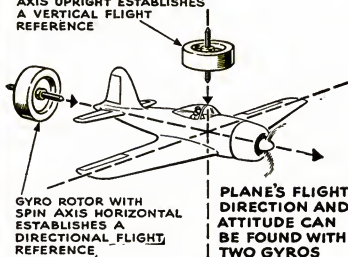
THE GYRO IS THE BRAIN OF THE SUPERFORTRESS' GUNS

At the left, below, is the central control gunsight that aims the guns of one to three turrets of the B-29 Boeing Superfortress. With its combination of gyroscopic, electronic, and mechanical devices it automatically computes lead angle, gravity, windage, and parallax in a split second. All the gunner has to do is hold his sight on an enemy plane and pull the trigger. At right, separate units removed from the plane show a gunner using the sight while a turret obeys electrical impulses carried by a cable.



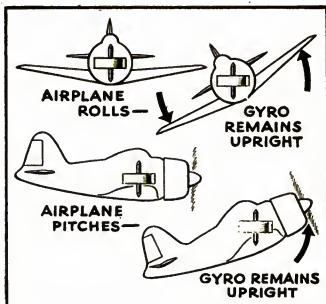
GYRO'S STABILITY IS USED IN AVIATION INSTRUMENTS

GYRO ROTOR WITH SPIN AXIS UPRIGHT ESTABLISHES A VERTICAL FLIGHT REFERENCE



GYRO ROTOR WITH SPIN AXIS HORIZONTAL ESTABLISHES A DIRECTIONAL FLIGHT REFERENCE

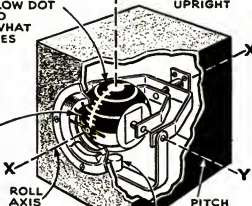
PLANE'S FLIGHT DIRECTION AND ATTITUDE CAN BE FOUND WITH TWO GYROS



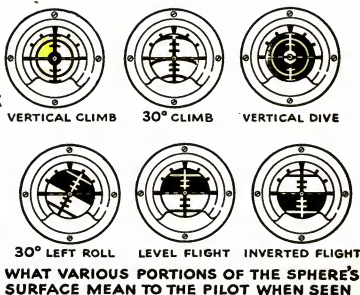
HOLLOW SPHERE CONTAINING GYRO REMAINS UPRIGHT WITH YELLOW DOT ON TOP, NO MATTER WHAT PLANE DOES

POLAR AXIS OF GYRO IS ALWAYS UPRIGHT

PILOT WATCHES SPHERE'S SURFACE THROUGH WINDOW



ELECTROMAGNET PULLS ON PIECE OF IRON IN BOTTOM OF SPHERE TO ERECT GYRO PERFECTLY



WHAT VARIOUS PORTIONS OF THE SPHERE'S SURFACE MEAN TO THE PILOT WHEN SEEN

ATTITUDE GYRO SHOWS PLANE'S RELATION TO THE EARTH

while our tanks kept on the move, firing with deadly accuracy.

It should be kept in mind that a small gyroscope, such as those in planes, gun-sights, and gun stabilizers, has no great power. A man can move one of these rotors out of its plane of rotation with his hand. What it does have is infallible accuracy when it is nicely balanced and freed from the element of friction to the degree made possible by precise manufacturing methods. The gyro in the tank, for instance, merely opens and closes magnetic valves, an operation that takes practically no power. It is just a matter of making electrical contacts. Oil pressure, kept up by an independent pump, does the work of pushing the gun breech up and down, counteracting every movement of the tank. The gyro tells it when to push and when to pull.

Let's not forget, either, that it is the same uncanny gyroscopic power that gives the biggest guns in our fighting ships a true vertical reference at all times so they can fire with accuracy regardless of roll and pitch. This is certainly an offensive use of utmost importance. So is the work of gyros that guide our torpedoes to send Jap ships to the bottom. The gyroscopes in torpedoes did us plenty of damage in the Atlantic, but in the Pacific they have been largely on our side.

And these are not the only important uses we are making of gyroscopes to speed this war to a conclusion. Now that our scientists have really tackled the problem of harnessing the gyroscope to man's purposes, there is no telling what important new services they may find for it in the years to come.

—GOLD V. SANDERS.

A dime is its landing field:

JEEP WITH WINGS

By DEVON FRANCIS

ABOVE the treeless volcanic isles at Japan's back door, a new kind of war has been fought with a weapon more than 40 years old. The unarmed airplane, introduced at the start of World War I, returned to service to help drive the Japs into their inner citadel.

In the fighting that marked the start of the Kaiser's war, the flimsy aircraft of the period were used solely for reconnaissance. In the mobile, seaborne fighting of the Mikado's war, the role of the plane that drops no bombs and shoots no bullets became that of an airborne scout car, ambulance, motorcycle, and artillery observation post.

Of all the weapons that have been given wings for fighting in a third dimension, the "grasshopper" plane, often fitted with an engine of less power than that of a small automobile, is the most versatile. Grasshoppers have been used for almost everything that requires transportation, even including the laying of telephone wire to advanced observation posts over mountains.

Because they are slow and fly at treetop level, and therefore make poor targets for either ground gunners or enemy fighter pilots, they are ideal vehicles for carrying messages, directing highway traffic, and dropping supplies to units cut off by the swift ebb and flow of battle.

The grasshoppers are the same thing as the small private planes that used to dot the grassy, postage-stamp airports throughout the United States before the war. They have changed only their garb. Some of them have a little more horsepower. They carry two-way radio. A limited number, flying for the Army, the Navy, and the Marine Corps, are equipped with stretchers for ambulance work.

They require no regular landing fields. The first of them on Guam—and they were the first American planes to land there, as well as on Iwo Jima—sat down on a short strip of ground bucked flat by bulldozers. They can put their wheels on the ground and stop in less distance than the span of a Superfortress wing. A favorite trick of the grasshopper pilot facing an emergency is to land in a treetop. It damages the plane,

THESE ARE THE ARMY, NAVY, AND MARINE GRASSHOPPERS...

PIPER L-4

INTERSTATE L-6

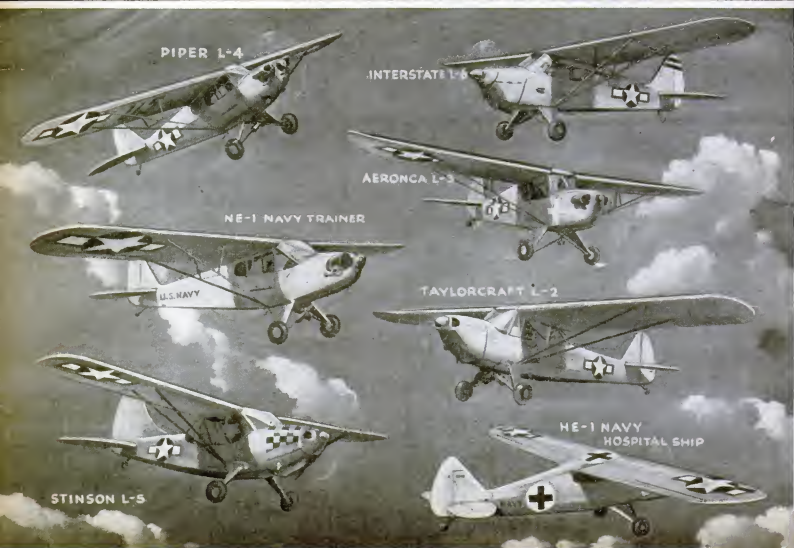
AERONCA L-3

NE-1 NAVY TRAINER

TAYLORCRAFT L-2

NE-1 NAVY
HOSPITAL SHIP

STINSON L-5





OKINAWA'S BATTERED CAPITAL is given the once-over by a Morine grasshopper. Scout plane flies low over flattened Naha, to seek out any signs of hidden Jap gun positions that may have survived.

but it's usually safe enough for the pilot.

With more affection than derision, the grasshopper has been called a flying egg beater, aeropoop, coffee grinder, and Maytag Messerschmitt. It might well be called an

AND THEY DO THESE JOBS



FLYING TIGER CUB? The shark-nose point job on this lightplane doesn't fool anybody. But the cubs are tough; their losses have been slight.

IN THE ARCTIC, the midgets don ski runners for landings on snow or ice. They are adaptable to any conditions, dependable, and economical.





GENERAL EISENHOWER often used his grasshopper to shuttle between headquarters and the front lines in the African campaign and on the Continent. Other commanders also used them. The airjeeps take off in 500 feet in still air. For landings, they sit down almost anywhere and stop in less than 200 feet.

EASY TO FLY. A grasshopper pilot has few instruments to watch. Originally designed for amateur civilian flyers, these planes use simple controls.



airjeep—aerial partner of the quarter-ton.

Airjeeps are at their best in artillery-spotting work. Flying at 25 to 100 feet above the ground, the pilot and his observer—they carry a crew of only two—can see everything on the ground.

During the invasion of Peleliu Island, in the Palau group, airjeeps were flown off carriers to direct Marine artillery fire. They hovered over the Jap positions and radioed ranges to the guns. During the shelling they retired to an altitude of 1,000 feet to avoid concussion. Then they swooped down to report the results.

They topped off their performance at this Jap outpost by directing the fire that destroyed a flotilla of enemy barges loaded with soldiers sent to reinforce the garrison holed up in Bloody Nose Ridge.

The first Marine airjeep outfit organized as a squadron (*Continued on page 210*)

*Your
Pin Up—*

C-54 SKYMASTER, built by Douglas, is an all-metal adaptation of the DC-4 commercial airliner. The four 1,350-hp. engines can speed its maximum weight of 30 tons 3,000 miles at 275 m.p.h.



JOANE



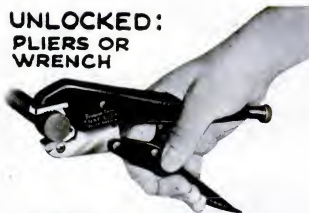
RADIAL-ARM SAW with a versatile elbow pivots right or left, and the arm mounting moves backward and forward in the rigid overarm. Special equipment converts the unit into a high-speed drill press. Made by Red Star Products, Inc., of Cleveland, the saw cuts miters of any degree, and the drill can be set for vertical, horizontal, or angular driving.

new Tools



A NEW HOLDER for welding electrodes, designed to allow unobstructed visibility and maximum accessibility for deep-pocket work, requires only $\frac{1}{2}$ inch of rod for a tight, efficient current contact in the holder jaw. The design permits use of two to four inches of rod wasted in other holders. "Shortstub" is made by Hollup Corp., Chicago.

UNLOCKED:
PLIERS OR
WRENCH



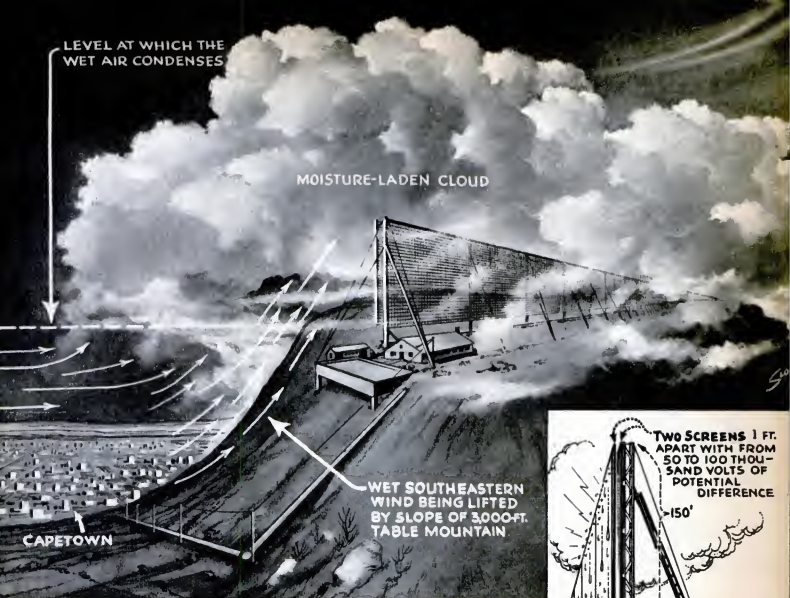
LOCKED: HAND VISE
OR CLAMP



DUAL ACTION of the toggle clamp below makes easier any drilling or assembly work on angular parts. It was designed for Consolidated Vultee by W. G. Bowlus, Ft. Worth, Tex. Photo shows clamp pad and handle in "down" position.



SWIVEL JAW of this combination pliers-wrench insures a full grip by the entire jaw length on a flat or irregularly shaped object. Locked, the tool becomes a hand vise. It is put out by Seymour Smith & Son, Inc., Oakville, Conn.



Squeezing Water Out of a Cloud

CONDENSER WOULD PROVIDE CAPETOWN'S WATER

AN average of 3,000,000 gallons of water a day may be extracted by means of electricity from the most famous cloud in the world—"The Cloth," which covers Table Mountain on the southern fringe of Cape-town, South Africa. This would supplement the city's water supply in the dry season.

To capture this supply, Chief Meteorologist Theodor E. W. Schumann, South Africa's leading scientist, proposes the erection atop the 3,500-foot-high mountain of two parallel fences of wire netting, one grounded and one insulated, with a potential difference between them of 50,000 to 100,000 volts. These wire screens—about 150 feet high and 9,000 feet long and set one foot apart—would, he says, condense the moisture in the cloud and collect as much as 30,000,000 gallons

of water a day under the most favorable conditions.

Experimenting with a small artificial cloud in his laboratory, Dr. Schumann has succeeded in condensing the vapor into a tube when the cloud was passed between two metal disks and a potential of 30,000 volts was maintained between them. This is the basis for his mountaintop screens.

Table Mountain's "Cloth" is created by a southeast wind that blows against the mountain and is forced upward. Cooling is caused by this ascent, the saturation point is reached at a certain height, and the cloud is formed. This cloud is actually replaced every 10 or 20 minutes, but the manner of its formation gives the impression of a permanent cloud on the mountain.



The Invader in the air. Its speed, climbing power, and maneuverability fit it for its many kinds of missions.

Plane of Many Faces

Switching noses makes the A-26 anything from a grass-cutting strafer to a high-level bomber.

By HAL BORLAND

YOU go down the line on an airfield and you see a group of them with cannon in their noses, then a group bristling with machine guns, then a cluster of them with Plexiglas bombardier greenhouses. You wonder if you're seeing things, for the ships all look alike except for the armament in those long, sleek snouts. You're seeing things, all right—you're seeing the Douglas

MACHINE-GUN NOSE packs six .50 calibers, four on one side and two on the other, for strafing or brushing with enemy fighters. These six guns spit nearly 5,000 bullets a minute, to say nothing of the four additional .50's in the two remote-control turrets.





Nearly a ton of defensive armor shields its vulnerable parts; it can better 200 miles an hour on one engine.

75-MM.-CANNON NOSE carries the big gun hitherto mounted only in the B-25 Mitchell medium bomber. Three other noses offer combinations of a 75 with two .50 calibers; a 37-mm. cannon with four .50's; and a 20-mm. cannon with four .50's. Just take your pick.

BOMBING NOSE is a Plexiglas "greenhouse," here festooned with .50 caliber ammo. Changing over from one nose to another can be done in the field in about eight hours with no special equipment except a crane hoist, which can be improvised easily.



A-26, called the Invader, rigged for just a few of its various missions. Tactically, the Invader is just about the most effective attack bomber in the books.

Watch it take off, as I did recently at the Air Forces Tactical Center in Florida, and follow it for a time in the air and you begin to understand why, new as it is, it is already making a gaudy reputation for itself over enemy territory. Officially it's an attack bomber, but it has more speed than the A-20 Havoc, which can get right out and travel. Yet it has more bomb capacity and a higher ceiling than the B-25 Mitchell, which is rated at 35,000 pounds loaded weight and 25,000-foot ceiling.

For a ship of its size—its wing span is about the same as the B-26 Marauder, but its fuselage is about the length of the Havoc—it takes off in a hurry. It climbs unusually fast, reminding you of a Havoc. Put it alongside a Havoc, however, and it steadily pulls away, proving its extra speed. For a medium bomber, it maneuvers very easily. This is particularly noticeable when it is in the air with a Marauder or a Mitchell,

which are not exactly slow in maneuver themselves.

Name your tactical job and the Invader can do it—strafing, skip bombing, high-level bombing, tank busting, pillbox busting, general attack, reconnaissance, smoke laying. It can go anywhere in a hurry, take care of itself in a mix-up with enemy fighters, climb or dive out of trouble, and come home.

Take the factor of armament and you begin to sense why the Invader is already rated the best utility ship in the air. It can mount anything from a 75-millimeter cannon to six .50 caliber machine guns in its nose. It carries additional .50's in upper and lower turrets. It can carry .50 caliber package guns under its wings. Just try to imagine a flight of such ships on a strafing mission!

Further, it is built to take a variety of noses on the standard frame—noses designed for anything from straight bombing to every kind of attack and strafing mission. In addition to an assortment of guns in the nose, both the top and belly turrets are

BOMB BAY AND BELLY TURRET. An extra-large bomb bay enables the Invader to tote a heavy load of explosives. Exact tonnage is secret, but the plane is known to be carrying 50 percent more bomb weight than it was originally designed to handle. Note the two pairs of bomb-bay doors, with belly turret behind the rear pair.





TRICYCLE LANDING GEAR and slender fuselage show up in this rear-end view. Four Douglas-type, double-slotted flaps—two under the wings and two between engine nacelles and fuselage—slow down the "hot" A-26 for landings on short advanced-base fields. Large control surfaces boost maneuverability.

equipped with twin 50's. And there is no reason why such a ship should not mount rockets instead of package guns under its wings.

Yet the Invader can operate with as few as two men, pilot and gunner. There is ample room for a third or even a fourth crewman if needed on a particular mission.

Two things contribute to this ship's versatility and tremendous punch:

First of all, it is fundamentally a fast, rugged ship of excellent design and flight characteristics. An all-metal mid-wing monoplane with single tail and tricycle landing gear, its twin Pratt & Whitney double-row engines develop as much power as the Marauder. Its sleek lines enable it to make the most of that power. All important drag elements have been eliminated or carefully faired in. Pilot's compartment is of teardrop design. Turrets are of low silhouette, close-set—so close that you have to look twice to spot the belly guns.

Second, it can be converted from one job to another by changing noses. This is made possible by standardized design and development of an assortment of noses. Quick conversion does not mean changing the ship's nose in a matter of minutes, but the change can be made in the field in about eight hours with no other special equipment than an improvised crane hoist. Eight hours is a considerable gain over the time need¹ to send a ship to a modification center for conversion.

At present, six different noses are available for use on the Invader. Some of these may be further altered or discontinued, as experience in the field dictates. Each has its special purpose, and none may be considered a "standard nose." Noses now listed, with various combinations of cannon and .50 caliber guns, are:

- 1—Plexiglas "greenhouse" for bombing.
- 2—Metal nose mounting one 75-mm. cannon.

- 3—Metal nose with one 75 and two .50's.
- 4—Metal nose with one 37-mm. cannon and four .50's.
- 5—Metal nose with one 20-mm. cannon and four .50's.
- 6—Metal nose with six .50's.

Watch the Invader sweep down across a field and you can imagine what the Germans have had to face when this ship was on a strafing mission, with a flock of those .50's spitting hot steel. Or what it can do to a tank column or a group of pillboxes, with that 75 cannon action, supported by all those .50's. And it comes in on such a sweep with baffling speed, gets away in a considerable hurry. If you were trying to face it down with an ack-ack gun you wouldn't get more than a couple of quick glimpses of it before it was gone.

It is easy to imagine what this plane can do on a skip-bombing mission. Its speed and bomb capacity should make it a highly respected ship in that category, for it comes in like the wind, weaves away with exceptional dexterity, and is gone.

Take it on as opponent in the air, and you would have plenty of trouble. Its turrets are of a type used with remote fire control. All four of the .50's in those turrets can be used to ward off attack from the rear or from either side. From the front, it is simply devastating. Offhand, it would seem that this ship has few, if any, vulnerable spots. Its guns can pretty well cover all approaches, and it can throw enough slugs to break the heart of any armorer loading its ammunition boxes.

Its field uses depend entirely on situations

as they arise. It was specially designed to perform any one of a dozen jobs and is not a composite of other models or an adaptation of earlier designs. It was expected to make obsolescent three top-ranking planes, all well known for their powers of devastation: the A-20 Havoc attack plane, the B-26 Marauder medium bomber, and the B-25 Mitchell medium bomber and attack plane. That's quite an order, but when you see what it can do you know that these other doughty ships are going to have to step right out to hold their prestige. For here is a ship with more speed, a higher ceiling, and a greater bomb capacity than any of those three; in addition it has considerably more firepower, carries close to a ton of defensive armor, and can cruise at better than 200 miles an hour on one engine. Obviously, a ship that can take as well as give a lot of punishment and still come home.

But it's that interchangeable nose that gives the Invader its tremendous tactical advantage. That's what makes it the equivalent of six ships in one. To remove a nose, which is about six feet long, only six bolts need be removed. When electrical and gun-control cables have been disconnected, the nose can be swung away, a new nose swung into place, fitted there, and bolted. It isn't as simple or as easy as it sounds, but the job can be done between late dawn and early dusk—all connections hooked up, guns loaded, and the ship made ready for a new kind of mission.

The same kind of job can be done for a ship with a damaged nose, too—a great ad-

A QUICK-ACCESS HATCH opens on pilot's teardrop cockpit. The Invader can be fought by two men—pilot and gunner—but there is room for four if the mission calls for them. In this photo you can see clearly where the interchangeable noses join the fuselage, just ahead of the nose-wheel opening.





SPEEDY ENGINE REPAIRS are made possible by engine-nacelle cowling that comes off in halves. A spark-plug wrench loosens the fastenings, and the top and bottom sections are taken off. Removing or replacing takes only a few minutes. Mechanics like the A-26. "For once," says one, "they thought about the 'mech'."

vantage from the repair and maintenance point of view. Naturally, after a ship has been in combat and wracked a bit, it isn't as easy to slip a new nose into place as a finicky mechanic might wish. But this ship as a whole gets high praise from the mechs who work on it.

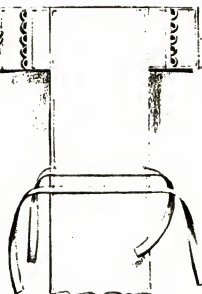
"For once," says one mechanic, "they

were thinking about the mech when they designed her. Why, you can even sit down in the accessory section. Imagine sitting down to change batteries! And the mags are out where you can get at them easy. Engine cowling is in two sections. Engines easy to service. She's a very sweet job, Mister, a very [\(Continued on page 206\)](#)



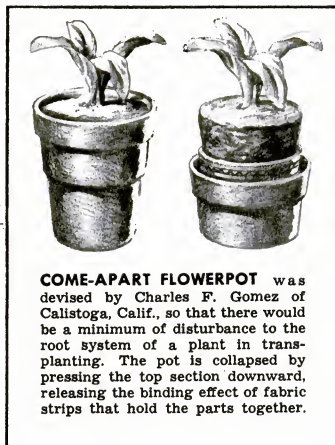
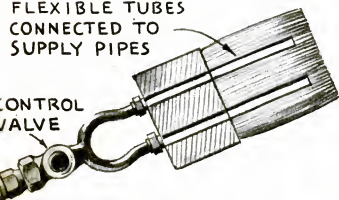
ABDOMINAL SUPPORTER

DOUBLE-DUTY DIAPER fills all the requirements of the traditional three-cornered pants and also includes a sewed-on abdominal band. It is secured on Junior by lacing tapes through loops on the bellyband, which does away with the need for pins. When the diaper is adjusted, a double thickness of material covers the baby's crotch. The designer is A. H. Sonnenberg, East Elmhurst, N. Y.



FLEXIBLE TUBES CONNECTED TO SUPPLY PIPES

CONTROL VALVE

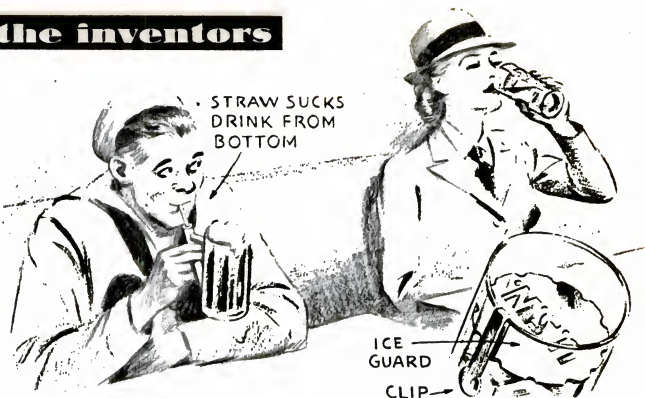


COME-APART FLOWERPOT was devised by Charles F. Gomez of Calistoga, Calif., so that there would be a minimum of disturbance to the root system of a plant in transplanting. The pot is collapsed by pressing the top section downward, releasing the binding effect of fabric strips that hold the parts together.



ALWAYS A FULL BRUSH of paint is assured the painter who uses the brush invented by George J. Rasch, Venice, Calif. Paint is fed through a hose that leads to flexible tubes within the bristles, eliminating the necessity of dipping the brush into the can each time paint is needed, and speeding up the job. A valve on the connection between the hose and the tubes controls the flow of paint into the bristles.

the inventors



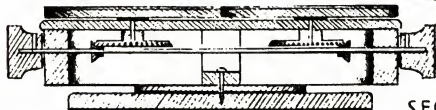
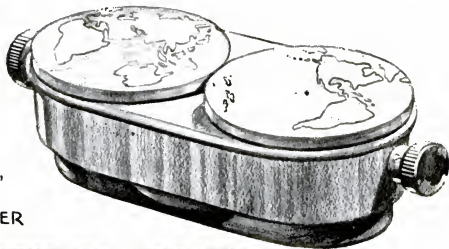
AIDS FOR DRINKING. Two innovations to make your liquid refreshments more inviting are the beverage cup (left) originated by V. Pera of Pinole, Calif., and the ice guard, called Ice-A-Way by its inventor, Raymond F. Swing of Seattle, Wash. The beverage cup is so designed that its contents may

be drunk through a straw inserted in a spout that forms part of the handle. The liquid is drawn from the bottom to avoid the drinking of "suds" or foam at the top. Ice-A-Way was designed to permit the drinking of iced drinks without allowing the ice to come into contact with the drinker's lips when the glass is tilted.

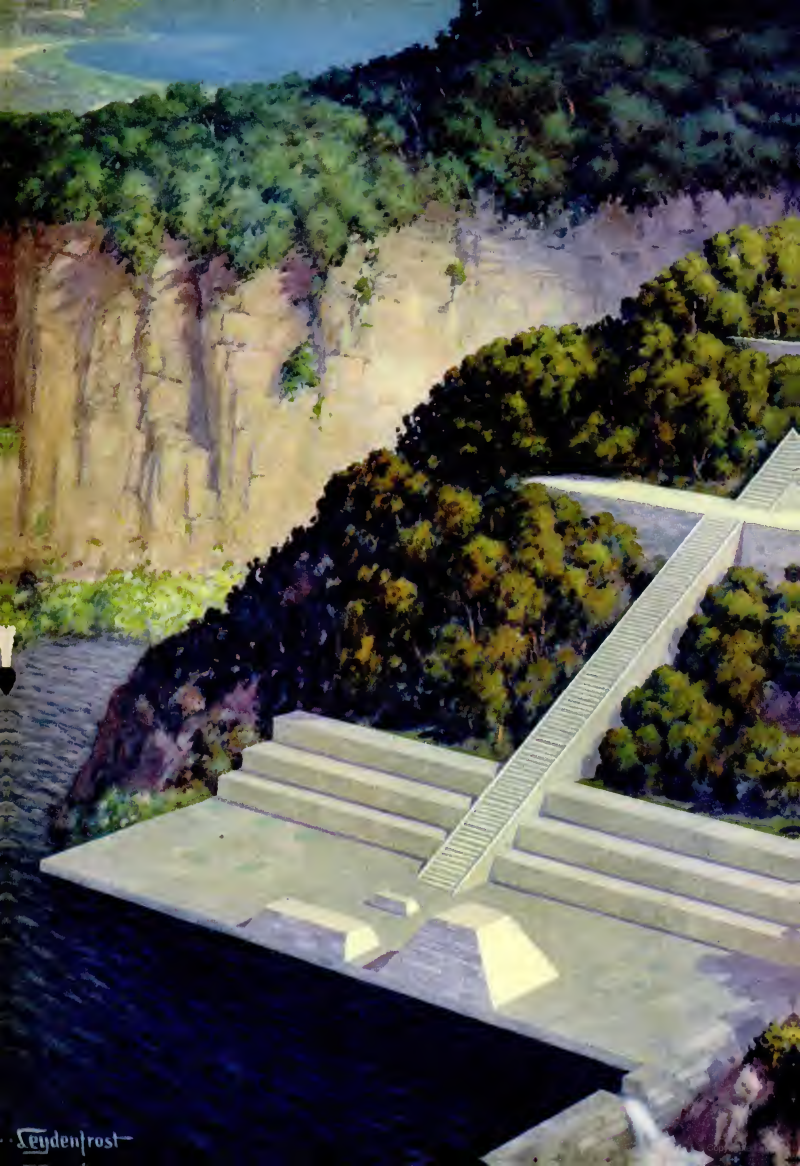
SHOWING THE WORLD at a glance so that the true relationship between the continents and countries may be readily seen is the purpose of this presentation devised by Paul von Rohlf of St. Paul, Minn. Maps of the Eastern and Western Hemispheres are mounted

side by side on disks which may be rotated by turning either or both of the operating knobs. When one disk moves clockwise the other moves counterclockwise, so that adjacent portions of the two hemispheres can be brought into their proper relationship with each other.

KNOBBS
OPERATE
BEVEL
GEARS ON
SINGLE SHAFT,
ROTATING
DISKS TOGETHER



SECTION





THE TEMPLE OF A THOUSAND STEPS

**"Ladder to Heaven" built by Mayan Indians 1,500
years ago shows skill of primitive engineers.**

By RICHARD CEOUGH

Director, Tepancoapan Explorations, Chiapas, Mexico

A THOUSAND years before Columbus found America, the Temple of a Thousand Steps stood as a kind of ladder to the Mayan Indians' heaven. The painting on these pages is artist Alexander Leydenfrost's conception of the appearance of that majestic monument before it was ravaged and concealed by time, the hand of man, and tropical erosion.

The temple was in a high valley of the Sierra Madre Mountains in southern Mexico. Its carefully cut stones were set in a mountainside by the voluntary labor of men who used neither beasts of burden nor wheels. The structure was so designed that it could serve for religious purposes and, also, as a defense work. It is evidence of an engineering civilization earlier than that of the Toltec and Aztec Indians in the Valley of Mexico.

Knowledge of this architectural wonder of prehistoric America has given us a cornerstone for a better understanding of the First Mayan Empire, and plans for its restoration now are being considered.

The series of flights of steps is about the length of a modern football field. Centuries ago, when black-robed priests doubtlessly tended a perpetual fire on one of the altars at the summit, devout Mayans may have ascended this Jacob's Ladder to offer their lives to their gods. And the view from the top of the temple is still so enchanting that an explorer finds himself loath to descend and return home.

The color picture is the artist's idea of the temple's approxi-



Time and nature have done their best to conceal the remains of the Mayan civilization. This green-clad hill was the site of the Pyramid of Yalmuz, Son of Sorrow, older than the Temple of a Thousand Steps.



The southwest corner of the upper pyramid of Agua Azul as it is today after about 15 centuries. There is evidence that stones were joined with hard cement.

mate appearance long before Europeans set foot in the New World. It was produced for **POPULAR SCIENCE MONTHLY** from field sketches and photographs made by a recent expedition conducted under my direction in Chiapas, the Pacific-coast state of Mexico that adjoins Guatemala. The expedition was sponsored by the Mexican Ministry of Education through the National Institute of Anthropology and History of Mexico, of which Dr. Ignacio Marquina is General Director, and Dr. Enrique Juan Palacios is Director of pre-Hispanic Monuments. I am now organizing another expedition under the same auspices to carry through the final stages of the exploration.

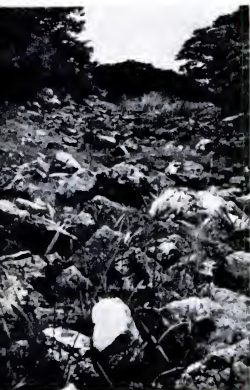
The general civilization of which this temple is dramatic evidence probably arose during the first century. Authorities say that its last known records appear in the

These bones from the ancient tombs of Agua Azul may be relics of devout Mayans who built the Temple of a Thousand Steps and served in its rites.





An idol found at Tepanapaan is one of the evidences of Mayans' religious worship in temple's heyday.



Here is the old spillway at Agua Azul. It was built to carry off water from the basin above the dam, and still works.



Upper part of the stela, or tablet, that stood at the foot of the final flight in the stairway of the temple. Experts believe that the battered hieroglyphs will establish the date of the structure.

seventh century. Europe was then in the grip of the Dark Ages, and most of North America was a thinly populated wilderness. But this fertile valley, blessed with an abundance of rain, supported many people in beautifully organized suburban communities.

In the beginning, the Mayans used nature's gifts for their religious purposes; hills, for example, were utilized as natural foundations for pyramids. But the many steps of this temple do not rest flat on the slope of the mountain. They are built out as an independent structure. Each stone was cut and fitted by workmen who had few, if any, metal tools. And the stones were held together with a hard cement or concrete containing small cracked stones, very much like modern concrete. Sand-and-

gravel plasters were used within the tombs.

In addition to understanding the rudiments of heavy-stone engineering, the Indians were aware of the use of paint, and this whole edifice may have been painted, although at present there is no direct evidence of this.

The Mayans have been described as peace-loving people, but this temple suggests that they appreciated the value of fortifications. The pyramids on the lower platform obviously could have been used as defense bastions; particularly from the sides of the larger one, effective sorties could easily have been made with clubs, hatchets, and spears. The intermediate platforms and terraces may have served the same purpose, as well as for solid, defensive operations. (Continued on page 206)



A Navy JM-1 takes to the air from a field at the important Admiralty Islands naval base. It will sharpen the eyes of AA gunners on our fighting ships at sea by giving them fast-moving, high-flying targets.

Sparring Partners for Navy Gunners



Ground-crew men go over one of the 2,000-hp. engines of a JM-1 in the course of the "60-hour" check that keeps these utility planes flying.

Tuning up. The JM-1 is an adaptation of the Army B-26 Martin Marauder bomber. Its speed has been increased by stripping it of all armament.

Official U. S. Navy Photos

WHEN you read about Navy antiaircraft gunners knocking Jap flyers out of the sky, you can give some of the credit to the hard-working JM-1 utility plane. This long-range, land-based craft is an adaptation of the Army's B-26 Martin Marauder, stripped of its armament and used for towing sleeve targets. Flying from airfields in the Admiralty Islands, JM-1s accompany our fighting ships at sea and give the men at the AA guns worthwhile practice on targets towed 20,000 feet high at speeds close to 350 miles an hour. This practice pays off in combat.



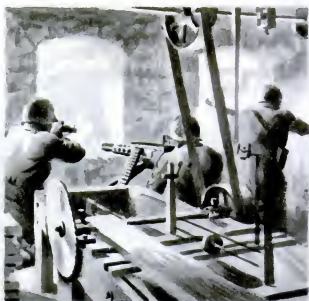


STRANGE FRUIT. A Navy FM-2 fighter plane (General Motors version of the Grumman Wildcat) left this souvenir of war in a palm tree in the Admiralty Islands. Coming in for a crash landing, it swerved off the field and buried its prop in the tree. U. S. Navy Photo.

How Cooks and Clerks



1 VILLAGERS WERE HAPPY when U.S. tanks and armored vehicles rumbled into Hotton, Belgium, a few days before Christmas, 1944. "The brave Americans" would save them from the Germans advancing in the Battle of the Bulge. They didn't know that only rear-echelon men remained in the town.



4 THE NAZI PAID a few minutes later when an Engineer bazooka team took him on. The rocket projectiles bounced off the tank's hide, but one ignited some gasoline spilled in refueling. The krauts tumbled out.

5 DEFENSE POSTS, manned by cooks, clerks, mechanics, and radio operators, had been set up in the local sawmill, schoolhouse, hotel, and other points of vantage.

8 AMMUNITION WAS LOW. The mortar crews had used almost their last rounds in breaking up that last threat. There was nothing to do but sweat it out while a couple of officers in a jeep ran the gauntlet of German fire on the north road to bring back a load of ammunition from the division CP.



Stopped the Panzers



2 **MORTAR FIRE** interrupted breakfast for the headquarters company next morning. Germans were trying to cut the strategic highway at Hottan.



3 **A DISABLED M-4**, left behind for repairs, went gamely out to meet a Nazi Mark V. Its first punch missed; it didn't get another.



6 **A WATCHFUL NIGHT** followed a day of pounding by mortar and rifle fire. A T/5, manning a machine gun, sprayed an advancing shape. Dawn's early light revealed a dead sheep.



7 **NEXT MORNING**, the defenders were reinforced by a platoon of 81-mm. mortars. When the commander of an outpost saw Germans massing, he phoned for mortar fire. Five rounds hit the target.

9 **DRIVEN BACK**, the Yanks formed their line along the railroad track. At 0200 the Jerries came on again, but this time the cooks and clerks held fast.

10 **RELIEF** came at dawn—five medium tanks with infantry support. The rear-echelon men had stopped the Panzers and held the vital road.



My Sweetheart Is a BLACK WIDOW

Fly with a night-fighter ace
and see how the famous P-61
plays blindman's buff with Jap
raiders—and wins every time!

By
MAJ. CARROLL C. SMITH

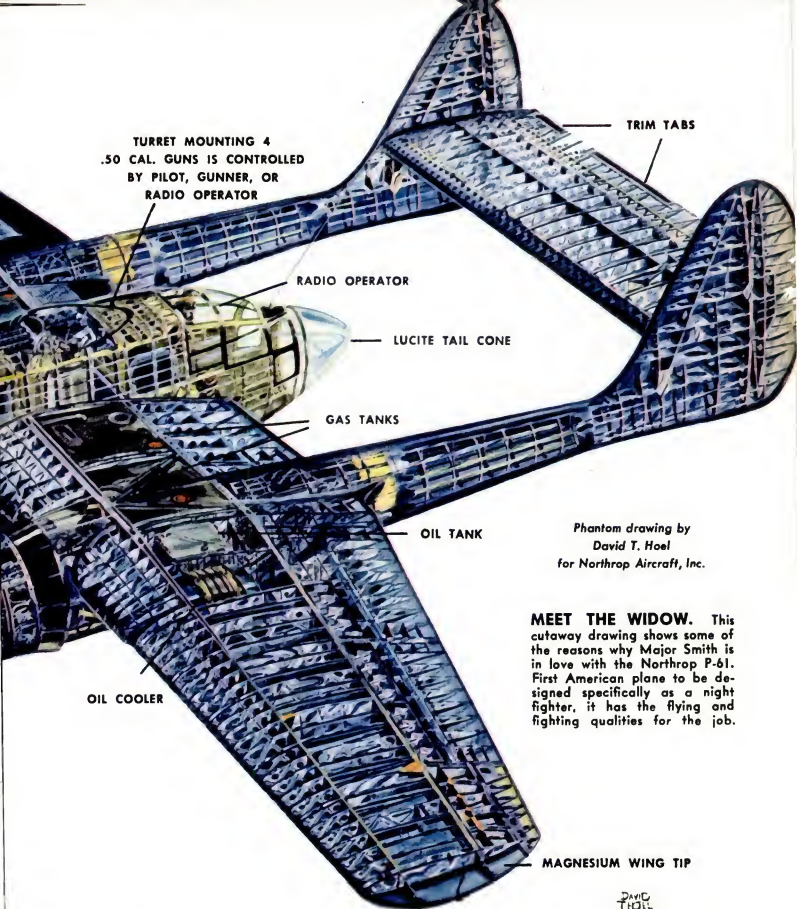
As told to **ANDREW R. BOONE**

THE AUTHOR qualified as the first night-fighter ace of the war when he bogged seven Japs in four of his 139 night missions in the Pacific. Five of the enemy planes fell to the 20-mm. cannon of his Black Widow "Time's o-Wostin'," and he got the two others when he was piloting P-38's. He has been awarded the Air Medal with one cluster, and recommended for the Silver Star and Distinguished Flying Cross. Twenty-seven years old, he is now serving on the staff of the Fourth Air Force Night Fighter School, at Hommer Field, Calif.



THAT Jap pilot tooling his twin-engine Dinah Mark II toward our airstrip at Morotai wasn't worried. At 8,000 feet his fighter was invisible (he thought), his 20-mm. cannon and 7.7-mm. machine guns would protect him in a clinch, and as a last resort he could climb a mile in 90 seconds or so to evade us.

He hadn't the foggiest notion that Lt. Phil Porter and I were floating in the



Phantom drawing by
David T. Hoel
for Northrop Aircraft, Inc.

MEET THE WIDOW. This cutaway drawing shows some of the reasons why Major Smith is in love with the Northrop P-61. First American plane to be designed specifically as a night fighter, it has the flying and fighting qualities for the job.

moonlit night over the field, throttled to minimum cruising. We were saving gas, to make sure we'd have plenty in case a Nip came over.

He still wasn't worried when our ground control picked him up and flashed the first order: "Darkie One from Nightie. Climb to 8,000 . . . course two zero zero . . . range about 12 miles." Instantly I turned my attention to my instruments. Phil

shouted instructions as I swung the Black Widow onto the new heading. I flipped on the water injection to pull another six inches of manifold pressure. That meant 200 to 300 more horsepower from the big Pratt & Whitneys . . . 300 feet a minute faster climb.

While ground control continued directing us toward the incoming fighter, I climbed and turned with everything jammed

to the fire wall. The Jap was headed for our field, bearing a load of medium bombs. A few more seconds, and we spotted each other in the brilliant moonlight, at a range of 2,000 feet. He then was within a mile of our base.

Talk about evasive action! That boy could fly: He was worried now, for the Nips had heard about these deadly Black Widows. Ours were fairly new, but those four 20-mm. cannons spouting flame and shells from the belly spelled certain and swift destruction to any fighter or bomber within range.

I could see him easily as he climbed. His maneuver was no good, for the Widow was climbing even faster. I began overhauling him at 17,500. Three bursts failed to hit. The fourth and fifth seemed to do little damage. For the sixth I managed to pull in within 150 feet of his left wing and cut loose with a full deflection shot as he roared past. Chunks exploded from the glistening Dinah. He fell, burning, a plume of smoke following him to earth.

This was not my first kill. Some time earlier, while flying a P-38 Lightning over Jap-held Alexishaven, New Guinea, on dusk

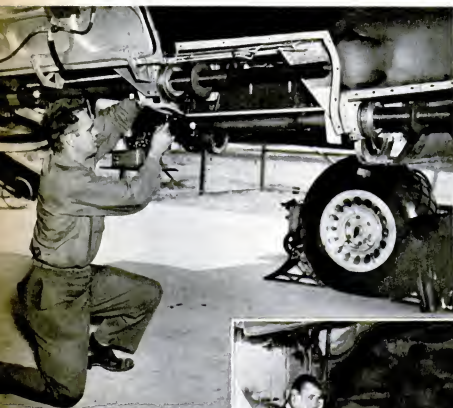
patrol, I had picked off a Val dive bomber as the plane was about to land. Three bursts of about 150, 30, and 20 rounds blasted its crew to their honorable ancestors. But now the Black Widows were beginning to arrive. Here we had the first American plane specially designed for night fighting. With it we could do things under cover of darkness that we dared not attempt with other types.

Three weeks later, while flying a Lightning, I snagged on successive nights a probable, one Betty, and a probable. The Betty is a twin-engine medium bomber similar to our Mitchell. Shooting down a Betty from a P-38 isn't like smashing one from a Widow in complete darkness. Searchlights picked her out and held her for me, and I ran her down after she had unloaded her bombs on Morotai. She couldn't climb like the Dinah, so I got her with two bursts from directly behind as we screamed down. My air-speed meter indicated 475; actually it was much more. Betty began to burn as I shot past, and cartwheeled into the water offshore.

Shooting down Nips at night gives you a grim satisfaction unmatched by daytime victories. Aided by detection equipment, you can stalk them as a tiger stalks its prey and blast them into the beyond, frequently before they know you're tailing them.

For the record, the Widows have "killed" nearly every plane shot at since they first started west from the Northrop plant in California in June 1944. Not one Widow has been lost, at this writing, to enemy action in the

20-MM. CANNONS (four of them) in the belly of the P-61 can knock out anything that flies. Once a "fix" is obtained on an enemy plane, these and the four .50 caliber machine guns in the top turret leave little chance of escape.



BIG NOISE is the result when ordnance men test the 20's on the ground. The box is placed under the fuselage to catch the empty shells.



TAKING OFF, the Black Widow climbs steeply and swiftly. The full-span wing flops which make this possible also give the big ship remarkably low landing speed, enabling it to use small fields at night. The twin fins and rudders, supported by monocoque tail booms, give a resemblance to the P-38 Lightning.

Pacific. I know of only one to be missing on a mission, and I have fairly good reason to think that its crew ditched near the Philippines, and that they are safe today.

I was skeptical of the first Black Widow I saw. "She's awkward as a box kite," I remember thinking. "She's too big and clumsy to be a fighter." But when you make high-speed stalls into a dead engine, in the dead ([Continued on page 207](#))

FOUR-GUN TURRET is being lowered of right into the crew nacelle of a new Widow. The .50 caliber guns will be set in the revolving drum at the top. Turret is electrically operated. Below, gun setter parallels guns with a bore-setting scope.



Why

SEVEN! Dice have been used for amusement and gambling since the days of the ancient Egyptians and the Greeks. Today's dice differ in no material respect from those of the earliest times, and our present game of craps is a simplified version of hazard, an old French game.

POSSIBILITIES. With two standard dice, exactly 36 different combinations are possible. The odds against throwing any given number are mathematically fixed. A 7, for instance, will come up approximately 166.6 times out of any 1,000 throws.

ONE WAY
TO MAKE A 2 ▶

TWO WAYS
TO MAKE A 3 ▶

THREE WAYS
TO MAKE A 4 ▶

FOUR WAYS
TO MAKE A 5 ▶

FIVE WAYS
TO MAKE A 6 ▶

SIX WAYS
TO MAKE A 7 ▶

FIVE WAYS
TO MAKE AN 8 ▶

FOUR WAYS
TO MAKE A 9 ▶

THREE WAYS
TO MAKE A 10 ▶

TWO WAYS
TO MAKE AN 11 ▶

ONE WAY
TO MAKE A 12 ▶



Dice Behave as They Do

**MATHEMATICAL ODDS PREVAIL IN CRAP SHOOTING
—IF THE CUBES AND PLAYERS ARE ON THE LEVEL**

By **GOLD V. SANDERS**

Photographs by **WILLIAM W. MORRIS**

LOOK into the science of the game called crap shooting, and you may be surprised to find that the number seven comes by its magical reputation honestly. It is the champion, not from superstition, but by right of mathematical merit.

With some ten million men in our fighting forces, a lot of craps is being shot. It is said that millions of dollars change hands every month. Most of the boys are rank amateurs. A few who might be called professionals with the dice are raking in the dough.

Since crap shooting is evidently here to stay, judging by its several centuries of popularity, it is high time its devotees learned something of the science of the game, just as card players study the technique of bridge. The odds can be figured exactly, and it is not hard to do.

There are 36 possible combinations of the two dice. Each number has a mathematical certainty to it. For example, there are six ways to make seven, and that is not true of any other number. The table on the opposite page shows the chances of each number turning up when a pair of standard dice are used.

Since the object of the game is to throw your point before seven comes up, the odds must be figured as between each number and seven. Six and eight are the best points, but the odds against them are six to five. When it comes to the ever-popular Little Joe, the point of four, the table shows that this is a very bad number, the odds against it being two to one.

The man who is throwing the dice is always on the short end, though a lot of crapshooters seem to be happy when it comes their turn to shoot. The rules of the game doubtless were made in an effort to even up

TWO SIMPLE WAYS TO TEST TRUENESS OF DICE

You can easily discover if dice are imperfect. Simply hold three cubes of the same size, as at the right, leaving a measuring space. Try a fourth die in this space, fitting it in the three different positions. A perfect die will slide in and out with no room to spare. Drop the dice into a glass of water. If any side is weighted, it will always turn downward.



MULLIGAN

ANY number of players. Five dice. A score sheet is kept, a line for each man:

PLAYERS	1	2	3	4	5	6	M	TOTAL
JONES				12				
SMITH	8							

The object is to make the highest score. Each player has three rolls for each of his seven squares. The second and third rolls are like the draws in poker, made to improve any pairs, or better, made on the first roll. After the third roll, the total spots on matching dice are added and placed in the square where they belong, according to denomination.

In the sample score sheet above, Jones made three fours on his three rolls. These were added and scored under the numeral 4. Smith has made four deuces, which added up to 8 and were placed under the numeral 2. The game ends when all players have filled all their squares, including mulligan, the seventh square.

Mulligan counts 24 and is made only by

completing the combination 1, 2, 3, 4, 5 with one, two, or three rolls. If the player tries for mulligan and fails, he enters a zero under M.

A player may draw to any number thrown on the first roll, whether it is paired or not. Say he rolls one six and leaves it. If he fails to better it, he gets a total of six in the 6 column. If a player does not like his first roll, he can pick up all five dice for his second roll, and do the same for the third.

BASEBALL

NINE innings are played. Two dice. Two players, or two teams.

Each point of the dice is a play of some kind, for or against the roller. Each side rolls until the side is out, that is, three outs to the inning. Scoring continues until the side is out. Following are the plays called for by the corresponding points:

Point	Play
2	Home run
3	Double play if man on base; otherwise, out
4	Base on balls
5	Out
6	Out
7	Out

this situation. That is why the thrower is given a chance to win on his "come out" roll by making seven or eleven. But the chances against this are still pretty high. It has been figured that from the moment a man picks up the dice, the odds are against him by 1.41 percent. Notice that in all gambling houses it is the guest who throws the dice, not the house.

Here are the odds against the thrower on each point:

POINT	ODDS AGAINST
6 or 8	6 to 5
5 or 9	3 to 2
4 or 10	2 to 1

That makes it plain that anyone who makes a side bet at even money that the thrower will make his point is playing the

sucker. He should ask for the proper odds on each number. It is all very well to shout for Little Joe or Big Dick (a ten), but don't back either of them at more than one to two.

Those are the mathematics when you are dealing with straight dice and honest players. They do not take into consideration the various forms of loaded and shaped dice or sleight-of-hand throwing. The only way to avoid these hazards is not to play with strangers. Those who ought to know say the sharps take a lot of money away from the amateurs in the armed services. *Yank*, the Army Weekly, has carried a number of articles on this, revealing the tricks of the trade.

A crooked player who can control dice—

HOW DICE ARE MADE

A cube is cut on a machine with diamond-tipped cutters, and left to season for a month. Then cavities 6/1,000 of an inch deep are drilled, and plugs cemented into them. Machining makes the plugs flush with the surface. The perfect cube has a tolerance of only 1/20,000 of an inch.



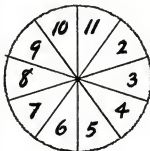
8	Out
9	1-base hit
10	2-base hit
11	3-base hit
12	Home run.

All men on base advance according to hits made. If desired, a diamond can be used with markers for men on base.

JACKPOT PIE

ANOTHER dice game, easy to learn, is played with a "pie" with cuts numbered as shown here:

Players roll two dice, each having one roll at a time. The player rolling a number places one chip on that corresponding piece of pie. When three chips have thus been placed on any piece, the next player to roll that number wins all three. Anyone rolling 12 (two sixes) takes all the money on all the pieces of pie. This game is from "At Ease!" by Jules Leopold (Whitese House, New York, 1943).



and this is a trick that can be acquired by long practice—does not worry about mathematics. He is no longer a gambler, but a sure-thing player. To amateurs it seems so difficult that they hardly suspect it when they are being fleeced by a sleight-of-hand artist. These sharps can pick up the bones, no matter in what position they lie, and shift them to the desired position in their hands. They can give them plenty of rattle without changing the position of the cubes, and then, with a fair degree of certainty, roll the desired number.

Bouncing the dice against a wall makes it far more difficult for these players, but some of them are said to be able to throw desired numbers that way, too.

There are various ways of loading dice by adding weight so that the heavy side will fall downward and give certain numbers more frequently than the odds call for. A popular fallacy is the belief that transparent dice cannot be loaded. The paint can be dug out of the holes drilled for spots, a light-colored metal put in, and the spots painted again.

Shaped dice of various kinds also are used by crooked players, giving them an unfair advantage by enabling them to know which numbers are (Continued on page 205)

BUNKO

THREE dice and any number of players. Cross marks are drawn on paper, three for each player, like this:

JONES X X X
SMITH X X X

Each player first rolls one die. The highest plays first. The lowest throws his die again to determine the trump. Assuming that four is trump, each time four appears it counts one point for the thrower. Five points cancel out one cross, as shown at the right:



The first player continues as long as he can roll at least one four to the cast. The first to cancel out his three crosses wins. If a player needs only one point to finish and rolls two or more trumps, he cannot score on that roll. He must score exactly what he needs to win.

Rolling three trumps at once wins immediately. Any other three of a kind scores five points, the same as five trumps.

THE ODDS AGAINST THROWING ANY GIVEN NUMBER WITH 2 DICE



"The Champ"

7 The odds are 6 to 1 against a player rolling a seven—"lucky" on first throw.



"Ada from Decatur"

6 or 8 Ada is not too hard to make—the odds against it being only 7.2 to 1. Same holds true for a six.

"Little Phoebe"

5 or 9 This lady is tougher. It's 9 to 1 against a five; and the same is true of a nine.



"Big Dick"



"Little Joe"

"Box Cars"



12 36 to 1, but not a point. Box Cars on first toss mean a loss.

4 or 10 It is 12 to 1 against Little Joe, Big Dick, and other fours or tens.

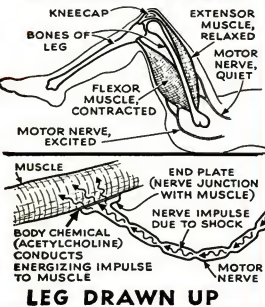
"Snake Eyes"



2 Same odds and results as with Box Cars. Nobody welcomes Snake Eyes.



WITHOUT CURARE



LEG DRAWN UP

Indian Dart Poison

CURARE, KILLER OF THE JUNGLE, ENLISTED

By ROBERT E. MARTIN

Drawings by STEWART ROUSE

SECRETLY, for centuries, the grotesquely clad witch doctors in the tropical jungles of South America have been taking the stems of certain woody, climbing vines and the bark and roots of other plants, performing mysterious ceremonies, and brewing a dark, gooey poison.

Into this, a hunter dips the point of a dart about a foot long and as slender as a matchstick. He then places this missile in a tube several feet long, made of the straight-

EXPLORER'S FALL FROM A HORSE STARTED THE LONG TREK

1 Richard C. Gill, jungle explorer, was thrown from his horse on a trail in the Upper Amazon. The jolt he received developed later into paralysis.



2 Recovering at home in the States, he learned the part the rare curare was playing in medical research of paralysis. In 1938 he returned to the jungle, where his Indian friends taught him how to brew the deadly concoction. Months later, he brought home a huge supply.



How curare reduces the danger from the convulsive-shock treatment for certain mental disorders. At left, the patient suffers violent muscular tremors, which can even cause him to break his own bones. Below, the same patient remains comparatively relaxed under the treatment, because curare has been injected to block junctions of nerves and muscles.

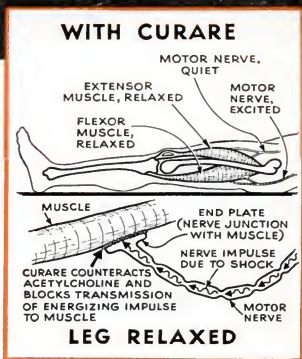


Saves Lives

BY MEDICAL SCIENCE

grained wood of the chonta palm. By holding this pipe to his lips and blowing, he can kill a jaguar nearly 50 yards away.

There is no sound. The dart need only pierce the hide of the game. Then, as the poison races through the blood stream of the beast, bird, or monkey that is hit, the muscles of the neck, the limbs, the abdomen, and the respiratory system are paralyzed. Death is certain, regardless of where the



TO GIVE DOCTORS A NEW WEAPON IN THE WAR ON DISEASE

3 Medical scientists purified and standardized the dart poison by tests on laboratory animals. Dr. A. E. Bennett, aided by Dr. A. R. McIntyre, introduced it successfully in convulsive-shock therapy.

4 Now, not only is the "black magic" making safe the shock treatment of mental disorders, but its relaxing effect renders a paralysis victim responsive to the various phases of muscle re-education.



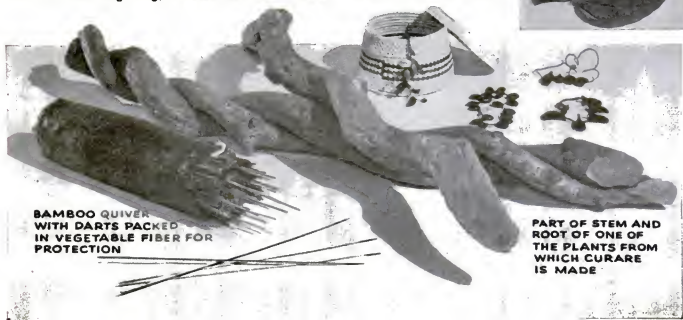


(Photo by R. C. Gill, courtesy Henry Holt & Co.)

INDIAN DART BLOWER can kill a jaguar at 50 yards with a curare-tipped arrow. Poison brings death instantly, but animal's flesh remains edible.



CURARE, applied to arrowheads, is a heavy, gummy, dark-brown paste, which, in the jungle, is made only according to strict ritual. Prepared for clinical use as a lifesaving drug, it resembles weak coffee.



BAMBOO QUIVER WITH DARTS PACKED IN VEGETABLE FIBER FOR PROTECTION

PART OF STEM AND ROOT OF ONE OF THE PLANTS FROM WHICH CURARE IS MADE

thin, light projectile strikes the animal. Yet the flesh is not contaminated. The hunter can eat his game without fear.

Now this same strange poison is being used by American physicians and surgeons. With its help, they are treating children afflicted with dreadful maladies, performing delicate operations successfully—and speeding the restoration of crazed persons to sanity!

How this came about is a story almost as incredible as the tales of Baron Munchausen. But this yarn is substantiated by the solemn, scholarly, statistical reports of distinguished men of science in their professional journals and the case histories of thousands of patients who have been treated with curare (pronounced "koo-RAH-ray").

Sir Walter Raleigh obtained samples of this poison from the Orinoco Indians in the sixteenth century. Laboratory research was undertaken and the Indian hunters' poison was tried in the treatment of some diseases in the nineteenth century. But the supply was limited, uneven in quality, and often contaminated. Hence, until recently, the jungle witch doctors retained their monopoly of the use of curare.

Richard C. Gill, a jungle explorer since 1930, won the friendship of some of these primitive people in Ecuador and took lessons in witchcraft from them. As an accredited witch doctor, he was finally permitted to hear the incantations and see the ritualistic boiling and filtering of plant materials from which they produced curare. He dined on curare-killed birds and beasts with the copper-skinned hunters.

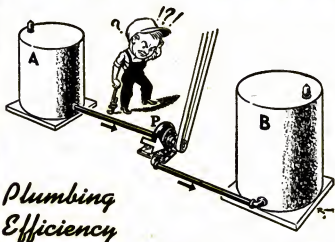
Even so, Gill did not realize how helpful this poison could be in civilized countries until, some time later, he was injured in a fall from a horse. (Continued on page 204)

INGREDIENTS of curare, some of which are shown below and at right, vary among the Indian tribes, as does the technique of making it. The container and trinkets are of Indian handiwork.



Five Brain Teasers

CLEAR thinking and plenty of patience will solve any or all of the puzzles by Dr. Harry Langman on this page. You'll have something to shout about, though, if you can get four out of five, and you're pretty good if you can solve only one or two. Here is just a hint about squaring Grandma's remnant: it doesn't have to be cut entirely along the lines shown. You will find the solutions on page 205.



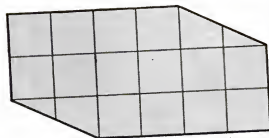
Plumbing Efficiency

THE setup of the rotary pump, P, will carry oil from tank A to tank B. If you had to reverse the direction of flow between the tanks for part of the time, how could you connect valves to the system so that you could pump oil in either direction, from A to B or from B to A?



For Triangle Counters

HERE are two problems to sharpen your wits on. In the left-hand figure, how many distinct, completed triangles can be counted? This isn't too hard, but look out for the arrangement at the right; it is for testing your ability to discover how many separate triangles there are, having for their vertices three of the ten dots. Hint: there are more than in the first figure.



Grandma Did It Easily

HOW did Grandma cut this remnant in two pieces so that, when they were sewed together, formed a perfect square?

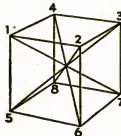
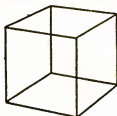


Unscrambling New York

SHIFT the letters (left) to order shown at right in fewest possible moves. A move 5-14 means that T has been moved to vacant 14 space.

Wired Cubes

STRETCH wire to form a cube (top figure). If each edge consists of a single strand, find the smallest number of pieces needed to complete the cube. If "solid diagonals" are also included (right), how few pieces will serve?





U.S.S. COOPER added a new chapter to the proud history of American destroyers before she went down with her guns blazing off Leyte in the Philippines on the night of December 2-3. Blocking the reinforcement of the Japs through the port of Ormoc, she beat off three aerial attacks, shooting down one or two enemy planes. Then she sank a big Jap destroyer and a warship of destroyer-escort size before a torpedo hit and split her.

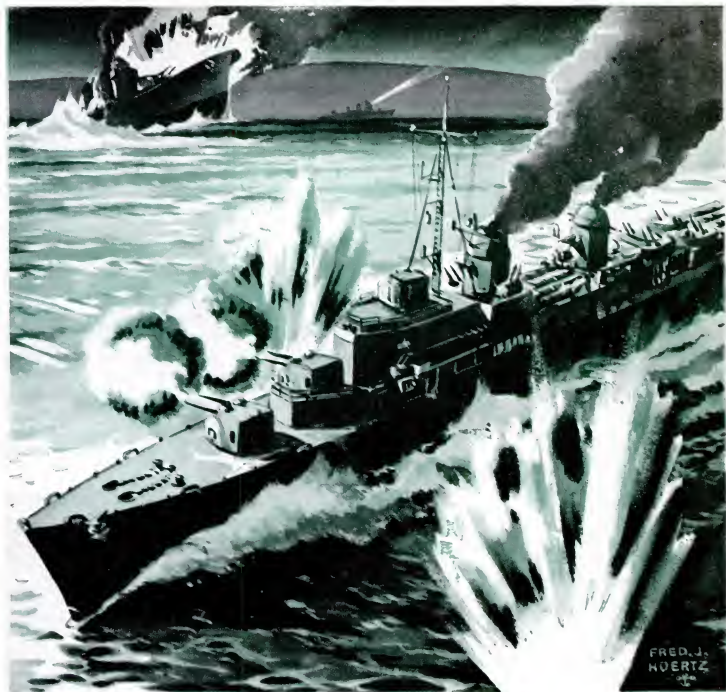
"Tin Cans" Dish It Out!

Back in 1877, naval experts were worried about torpedo boats. The answer was the destroyer—now one of the most useful tools of seapower.

By ALDEN P. ARMAGNAC

SCRAPPIEST of warcraft, they stand up to anything afloat, including battleships. Ton for ton, they outgun all other men-of-war. On the same basis, the propelling machinery that gives them their dashing speed is the most powerful. High seas inundate their decks, they roll until masts stand mid-

way between sky and water, and sandwiches are stormy-weather fare until pots and pans will stay put on galley stoves. They are about the largest warships whose men all know each other by first names. Crews openly blast with seafaring language, but secretly love, these sailors' ships that laymen call destroyers, that the Navy Department lists as DD's, and that will always be



known to the men aboard them as tin cans.

A destroyer of our 2,100-ton *Fletcher* class, last on which details are available, illustrates what a modern destroyer fights with. Five double-purpose guns of five-inch caliber shell surface craft, or may be elevated to fire on planes. Antiaircraft guns of 40-mm. and 20-mm. size provide additional firepower. Also double-purpose, the AA's can be depressed to riddle surfaced submarines. Two deck-mounted sets of torpedo tubes, five in each mount, invite healthy respect from enemy warships. Depth charges dispose of submarines under water. Though our latest and heaviest destroyers of the 2,200-ton *Allen M. Sumner* class remain pretty much under wraps, it may be said that increased armament principally accounts for their greater tonnage.

From its guns alone, a *Sumner*-class destroyer throws more than a ton of steel in only 15 seconds, as Japanese warcraft have already learned to their dismay.

As might be suspected from its variety of weapons, a destroyer performs countless missions. Supporting amphibious landings, naval opinion holds, represents the outstanding innovation among destroyer uses during World War II. Based on such successful tests as the Normandy invasion, in which 30 U.S. tin cans participated, the procedure begins with a preliminary long-range bombardment by battleships and cruisers. This reduces to rubble the massive fortifications that only their heavy shells can penetrate.

Now comes the destroyers' turn. Able to maneuver in shallow and constricted waters, they steam close to shore, to locate and put



Y GUNS (right) toss depth charges far out on both sides to crush lurking submarines. Above, an "ash can" hurls up a geyser of water as it explodes.



out of action all remaining gun positions commanding the intended beachhead. Of course, this is simply throwing the rule book overboard, for a square hit from a six-inch shore battery can demolish a destroyer—which has no armor worth mentioning—as thoroughly as a salvo from a battleship's big guns. But when the fate of a great invading army hangs in the balance, destroyers become expendable. It cost us the destroyers *Meredith* and *Glennon* to put our troops ashore at "Utah Beach" in Normandy, a price well justified by the success of

the landing and the enormous over-all saving in casualties.

No heavy warship, fleet, or convoy would dream of leaving port in wartime without an escort of destroyers to "screen" it from attack, especially by enemy submarines. Task forces of destroyers also hunt submarines on their own. The team which destroyed more submarines than any other in naval history consisted of the four-stacker destroyers *Borie*, *Barry*, and *Goff*, operating with the escort carrier *Card*.

One stormy night in the North Atlantic,

TORPEDOES are fired by "impulse charges" from multiple tubes that are aimed like guns. The white "fish" below is a dummy; others are real war heads.



FIVE-INCH GUNS of main battery can be used against subs, surface craft, or planes. Mounts are protected against shrapnel, but are not armored.



THE DESTROYER'S WEAPONS



20-MM. OERLIKONS guard the destroyer against low-flying enemy planes. Independently controlled, they fire tracer shells at intervals for correcting the aim.



the *Borie* spotted a U-boat, which crash-dived. Depth charges brought it back to the surface, and the *Borie* rammed it. Freeing itself, the sturdy submarine attempted to torpedo the destroyer. But a well-placed shell from the *Borie* carried away the U-boat's conning tower and ended the battle. The stern of the submarine tilted skyward, and it nose-dived to the bottom. Severely damaged in the encounter, the destroyer stayed afloat only long enough for another ship to rescue nearly all of her crew. In memory of her valiant fight, her name has been reassigned to one of our newest super-destroyers.

Laying a smoke screen—an important destroyer mission—contributed to the



40-MM. BOFORS guns in twin mounts are dual-purpose weapons, used against planes and warships.

TRACERS weave a deadly web around a Japanese barge in a night battle off Vella Lavella Island in the Pacific. American destroyers helped block an enemy attempt to land new troops under warship escort. By night or day, tracers show gunners whether shells are finding their mark.





STORMY WEATHER often pounds destroyers as mercilessly as the enemy. This Canadian vessel bears the scars of winter gales encountered on Atlantic convoy duty. Sea-boats were stove in, stores flooded, below-decks awash.

smashing American naval victory in the Second Battle of the Philippines, now officially renamed the Battle for Leyte Gulf. When a powerful Japanese fleet made a surprise sortie from the central channel, guarded only by our light carriers and destroyers, the tin cans raced between the opposing forces, billowing dense smoke. Two of them, the *Hoel* and the *Johnston*, failed to come back. But under their cover, the carriers were able to launch their planes, and, having done all they could, to retire until American reinforcements put the bomb-battered Japs to flight.

In a full-dress fleet action, normally covering a vast expanse of sea, destroyers do the infighting—attacking enemy destroyers, cruisers, and battleships as they charge across the distance between the majestic lines of big vessels. Two of our own major naval engagements—the Battle of Guadalcanal and the Battle for Leyte Gulf—gave our destroyers their chance against battleships, though the narrow waters in which they took place turned stately maneuvers into wild melees.

Lasting only 24 minutes, the midnight Battle of Guadalcanal has been termed by Fleet Admiral

HOW THE DESTROYER GREW: AT FIRST A COUNTERWEAPON,



1877

First torpedo boat designed to use the Whitehead self-propelled torpedo was H.M.S. Lightning. Her steam engine gave her a speed of about 19 knots.



1890

U.S.S. Cushing was our Navy's first "modern" torpedo boat. Rated top ship in her class, she was 139 feet long, did 22½ knots with her compound steam engine.

Only U.S. destroyer sunk by enemy action in World War I, the *Jacob Jones* (below) belonged to the 1,050-ton Conyngham class, our first oil-burners.



1915

Our first destroyers after World War I were ships of the new Farragut class. About 1,400 tons, 334 feet long, 36 knots. Had five 5-inch, four 40-mm. guns.



1935



SHE FOUGHT ON! One of the bravest performances in American naval history is pictured in this water color by Lt. Dwight C. Shepler, USNR. In the Santa Cruz battle, October 26, 1942, a flaming Jap torpedo plane crashed on the foreccastle of a U.S. destroyer. Ammunition stowed on deck went up in a terrific explosion, but the gallant ship kept station and never stopped firing while the blaze was put out.

IT HAS GAINED IN SIZE AND POWER WITH NEW DUTIES



1900

Then came the "torpedo-boat destroyer," pioneered by the British Havock and American Farragut. Above is a ship of our Truxton class: 435 tons; speed, 30 knots.

Last U.S. prewar type was the Benson class—341 feet long, 1,630 tons, 39 knots. Armament (before Pearl Harbor) consisted of five 5-inch, four 1.1-inch guns.



1909

U.S. destroyers took on steam turbines and three-inch guns with the Flusser class. Their powerful engines gave these 700-tonners a 30½-knot speed.

U.S.S. Catten, below, is typical of the destroyers built since the beginning of the war. These ships keep getting bigger, faster, and deadlier.

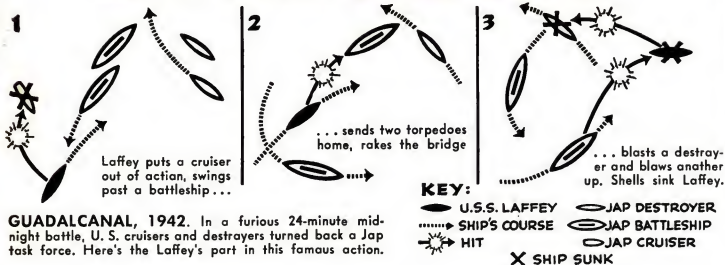


1940



1944

BATTLE TACTICS ★ DESTROYER LAFFEY



GUADALCANAL, 1942. In a furious 24-minute midnight battle, U. S. cruisers and destroyers turned back a Jap task force. Here's the Laffey's part in this famous action.

Ernest J. King one of the most furious sea decks in history. In that time, an out-matched American force of five cruisers and eight destroyers repulsed a Japanese task force of two battleships and 16 other war-craft bent on recapturing the island from American invaders. "We want the big ones," radioed the American commander, Rear Admiral Daniel J. Callaghan. So the destroyer *Laffey*, having put a Jap cruiser out of action, fired two torpedoes into a battleship—and then, cutting past its bow, raked it with gunfire and blew off its bridge. Unable to depress its guns, the Jap had no reply to this American impudence until the *Laffey* put one destroyer out of commission, blew up another, and then was sunk by battleship fire. Meanwhile several other U. S. destroyers scored torpedo hits on battleships, the *O'Bannon* being credited with three.

It was also before daybreak when a Japanese force headed by two battleships attempted to traverse the southernmost channel through the Philippines, in the

three-ring Battle for Leyte Gulf, last October. At this point, Vice Admiral J. B. Oldendorf was ready for them. Since the narrow channel of Surigao Strait gave him little room to deploy his destroyers, he lined them up along the shore, backing up this advance force with cruisers and battleships. Steaming squarely into the trap, the Japanese vessels suffered three co-ordinated destroyer attacks with torpedoes, and salvos from our heavy ships then finished off the two Japanese battleships and virtually the entire contingent.

Just how a destroyer aims and fires its torpedoes, by the way, makes an interesting contrast with undersea boats. Submarines discharge them under water, with compressed air. But it takes more than a whiff of breeze to toss overboard a Mark 15 destroyer torpedo, more than 20 feet long and weighing 3,400 pounds with its war head of TNT. So the torpedo gets its start from an "impulse charge" of black powder.

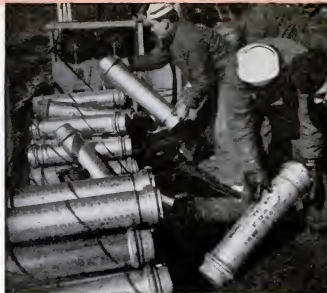
Sitting astride a bank of tubes, a torpedoman's mate re- *(Continued on page 203)*

Deck and superstructure reflect the flash of the guns as a "tin can" hammers enemy ships in the night battle off Vella Lavella (page 131).





HEALTH. In the tiny sick boy, the ship's doctor (a lieutenant), aided by pharmacist's mates, examines ailing crewmen and dispenses medicines.



WORK includes packing precious brass shell cases from the five-inch guns into aluminum containers. They are shipped back home to be loaded up again.

CHOW comes from a spotless galley run by about 10 men. These pork chops reached the chef frozen solid. When one meal is finished, next is started.



REST. Crew's quarters have triple-deck bunks with fireproof mattress covers. Men often eat off trays in their bunks, as messroom holds only about 35.



SUPER-DESTROYER.

Ships of our Allen M. Sumner class, such as the Cooper (left), are so big and powerful that in the last war they would have been classed as cruisers. Much of the great weight (2,200 tons) went into increased armament. The guns can throw over a ton of steel in 15 minutes.

What's New in Modern Living



JUST RELAX, and this chair relaxes with you. Invented by Lloyd Melleski, of Miami Beach, Fla., the beach chair shown above assumes and holds any position from up-

right to prone in response to pressure exerted by the user. Melleski has offered it to military hospitals. Actress Ann Sheridan shows how it's used.



DARK ROADS are safer for pedestrians who carry a lantern flashlight, above. The case is made of red lucite and glows brightly when the light is on. It can be held by an end loop, so that while the flashlight illuminates the ground, the luminous body acts as a taillight.



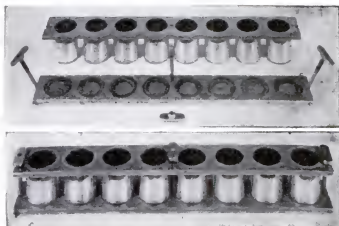
CIRCULAR fluorescent tubes have been designed by several manufacturers to meet the expected demand for portable lamp fixtures, according to the Illuminating Engineering Society. Like the straight tubes, these require ballasts.





SWISH the soap saver for a tub of suds. The cylinder is packed with scraps of soap too small to be used by themselves. The device is made by the R-System Co., of Chicago.

CELLAR TO ATTIC cleaning is projected for this combination vacuum cleaner soon to be put into production by the Eureka Vacuum Cleaner Co. It consists of an upright unit, a tank unit, and interchangeable attachments.



ICE TUBES instead of cubes are formed by this freezing tray invented by Roy M. Cummins, of Akron, O. Used in a refrigerator, the tray turns out perfectly formed cylinders that can be dropped into vacuum bottles without being chipped or melted down to size.



WATCH-POCKET WALLETS, measuring only $2\frac{1}{4}$ " by $3\frac{3}{8}$ ", are being made by the Arel Photo Supply Co., of St. Louis, Mo. Unfolded three ways, the billfold is just large enough to hold paper money; it has a coin purse and a transparent window for identification cards.



SPOTS AND STAINS can be rubbed out of fabrics with a compressed-powder eraser made by the Duncan MacKenzie Co., of New York. The chemical in the stick reacts upon the stain within a few minutes. It is dry and odorless, and is said to be harmless to colors and fabrics. Greasy spots in particular can be treated with this cleaner.

Gus Turns High-Pressure Salesman

By MARTIN BUNN

"HELLO, Mis-tair Veel-son!" Gus Wilson looked up from his workbench toward the Model Garage shop door where a bright, spring sun revealed a squat, dark figure in stained clothes. The visitor took off a floppy hat and, with an exaggerated gesture, swept it to the floor as he bowed low. Then he advanced into the shop, teeth gleaming white in an ingratiating smile under a long black mustache.

"Oh, hello, Tony," Gus said, returning the greeting with little cordiality. "So spring's here. When you gypsies show up, that makes it official. What did you come in for—to bring back that monkey wrench you snatched the last time you were here?"

Tony's swarthy features registered bland innocence. "Moonkey ranch?" he asked. "What ees a moonkey ranch?"

Gus shrugged. "Well, what do you want now?" he demanded.

Tony edged up to the bench, and Gus saw a covetous gleam in his dark eyes as his glance ranged over the tools on it. "I come to buy a bat-tair-ree, Mis-tair Veel-son," he said. "Mine, he go flooye all the vay from Sout' Car'lina." A grimy hand moved stealthily toward a peening hammer. "You got goot bat-tair-rees, Mis-tair Veel-son?" "Get your mitts off that bench, and keep 'em off. See?" Gus snapped. "Batteries? Sure, we've got swell batteries. You go into the office and pay Mr. Clark 14 bucks, and I'll put one in your bus."

"You put heem in," Tony suggested, "an' I pay you five dol-lair now an' the rest tomorrow. Ho-kay, Mis-tair Veel-son?"

"Scram," Gus laughed. "I'm busy."

Tony was silent for a moment. Then he tried again. "Mis-tair Veel-son, you sell a five dol-lair bat-tair-ree? Ho-kay?"

"We haven't any secondhand batteries," Gus told him with finality.

Tony went into a lengthy lamentation about the trouble he was having with his



worn-out battery. It was interrupted by the appearance of Joe Clark, who glared when he recognized the gypsy.

"Get out of here," Joe yelled. "Last year you thieving gypsies swiped a box of spark plugs and an inner tube. Get a move on! Beat it, or I'll call the cops."

Tony saw the game was up, and he made a complaining but hasty retreat.

Joe turned to Gus. "Jerry Corcoran just phoned," he told his partner. "He wanted to remind you that the trout season opens tomorrow and suggested that you take the morning off and go to Brawley Brook with him. He doesn't have to report to the State Police Barracks until afternoon. Well, what do you say? It will do you good. Shall I call back and say you'll go?"

Gus went into a long speech about why he couldn't go—too much work to be done in the shop, the water too cold for trout to take a fly, and, as a clincher, too many fishermen on opening day.

Joe laughed at him. "You say all that every year," he pointed out, "and every year you wind up by going. I'll tell him



From the top of the ridge they saw a man lift something out of Gus's car and put it in another parked alongside.

you'll be along tomorrow morning—as usual."

"Oh, all right," Gus weakened, none too reluctantly. "I'll be a sucker again. Tell him I'll pick him up about six."

BDRAWLEY BROOK at seven o'clock the next morning was, as Gus told State Trooper Jerry Corcoran, even worse than he had expected. Every pool was rimmed solidly with fishermen, and on every riffle they were bumping into each other. A flood of ice-cold and badly roiled water was swirling turbulently down the stream, and the fish were staying on the bottom.

After a miserable half hour spent trying—most of the time unsuccessfully—to find enough free space for a cast, Gus waded ashore and began taking his rod apart.

"Quitting?" Jerry demanded.

"Call it that if you want to," Gus told him. "I call it having a lot more sense than I had when I came out here."

Jerry started to unjoint his rod too. "I guess there's no chance here," he agreed. "Let's go over to Rocky Creek—back in the woods where we won't have company. I

know a hole that ought to have fish in it."

"Waste of time," Gus said. "No self-respecting trout will take a fly with the water the way it is today."

Jerry grinned. "I've got a can of worms—brought them along just in case," he confessed. "You're not too proud to fish with worms, are you?"

"Let's go!" Gus retorted.

They got into his old but sweet-running roadster and started for the upper reach of Rocky Creek. When they came through a big patch of woodland, they saw a number of cars parked in a field ahead.

"More fishermen," Gus growled. "Why don't they park at the end of the road?"

"They're not fishermen—they're gypsies," Jerry put in. "There's a gang that camps there every spring. We have to keep an eye on them or they wouldn't leave a chicken in the county."

There were half a dozen battered jalopies in the field. A crowd of women in long, bright-colored skirts and dirty children in assorted rags milled around a cooking fire a short distance away. Tony was standing

at the side of the road, and he grinned and waved his hand at Gus as the roadster passed him.

"Friend of yours?" Jerry asked.

"Not so much so that he didn't swipe some stuff from the shop last year and try to talk me out of a battery yesterday," Gus told him. "But I sort of like the old pirate."

The road ended at the edge of the woods halfway up a fairly steep hill. Gus turned his roadster before they got out. "Somebody else might park here, and we might have some trouble turning around," he remarked. They took their tackle and followed a half-overgrown path over the ridge and down the far slope.

"This is the place," Jerry said when they came to a creek after 15 minutes of walking. "There's a deep hole under that high bank." He produced his can of worms. "Now we'll catch some fish."

AN HOUR later Gus landed his third trout. "Let's leave some for somebody else," he said with satisfaction.

They disjoined their rods and started back. At the top of the ridge Jerry pointed to a car parked alongside theirs. "Somebody's doing something to your car," he warned.

They saw a man lift something out of Gus's car, hurriedly put it in his own, and drive away. By that time they were running. "It's that Tony," Gus panted.

Jerry is young, and he beat Gus to the car. "He got your battery. We're stuck."

Gus didn't pause to regain his breath. He grabbed the battery cable, quickly wrapped a handkerchief around the terminal, and wedged it in the empty battery carrier. Then he released the brake and told Jerry: "Give her a push and jump in!"

The car began to coast down the grade with increasing speed. At 15 miles an hour Gus switched on the ignition, shifted into high, and gently let in the clutch. The engine coughed and started.

Although Tony had a half-mile start, they overtook his old, worn-out bus rapidly. "Pull over," Jerry roared, opening his fishing coat and pointing to his badge.

"Ah, Mis-tair Veel-son," Tony smirked as he stopped. "You breeng the bat-tair-ree I buy yesterday, so I take heem out your car. Ho-kay? I hope I make no mees-take."

"It's not O.K., and you made a big mistake. You're under arrest," Jerry growled.

"Wait a minute, Jerry," Gus said with a wink. He turned to Tony. "Are you sure

Tony smirked. "You breeng the bat-tair-ree I buy."



you're satisfied with the battery?" he asked. "Remember, any battery in the shop is \$14. Did you get the one you want?"

Tony grinned ruefully and brought out a fat, greasy roll of bills. "Sure, he's a fine bat-tair-ree," he said and peeled off \$14.

Gus took them. "No complaint," he said. Jerry chuckled, but he told Tony seriously: "Now, you—I'll be out this way tomorrow morning, and when I get here you and your gang had better be somewhere else." Admiration crept into his voice as the squat man drove away. "Gypping a gypsy—14 bucks for an old battery!"

"I didn't gyp him. It was a new battery—I put it in just last week. But it'll do his soul good to think that he may have been gypped for once. It's lucky I kept the motor running while we were talking to him or we'd be the ones stuck."

"Say!" Jerry cut in. "How did you run this far without a battery?"

"It's nothing remarkable," Gus laughed. "But I wouldn't advise it except in an extreme emergency. You remember we actually started on a grade when you gave me a push. I had wrapped the battery-cable terminal to prevent shorting, and the generator supplied current after the engine began turning over fast enough. But if you ever have to try it, don't drive too fast, for it's hard on the points, coil, and condenser."

"Without a battery in the circuit, a generator is likely to build up too high a voltage. That burst of speed that overtook Tony may have cost me more than the profit on the battery. I'll check as soon as we get back to the shop. And don't yell at me to get you to work in a hurry—I'm staying under 25 until I put in another battery."

LONGER LIFE is in prospect for engines equipped with new "tri-alloy" bearings developed for military needs by the Ford Motor Company. Instead of cadmium, a metal in widespread use for bearings before the war, the new material consists of about 35 to 40 percent lead, 4.5 to 5 percent silver, .5 percent iron, and the rest copper. Tests have indicated the new bearings last three times as long as regular ones—even under the most trying conditions. When used on heavy-duty trucks, some showed no measurable wear after more than 50,000 miles. At the right, one of the bearings is being fitted to an engine at a Ford plant.



NO TOILSOME POLISHING is needed to give an automobile new luster when you use a cleansing solution produced by Parks Associates, of Glendale, Calif. After the car has been washed, the cleanser is applied with a cloth, an area about 3' square being cleaned at a time until the job is completed. Then it is rinsed off with water and allowed to dry. The makers assert that by using this cleaner it also is possible to renew the brightness of chrome or other highly-polished metals pitted with salt water. The manufacturer recommends it for furniture, tile, walls, and linoleum.

CHECKING A PISTON RING for trueness of periphery and width of gap requires only five seconds with an electronic gauge produced by the Sheffield Corporation, of Dayton, Ohio. After the ring to be tested has been inserted in a master ring of correct dimensions, the entire assembly rotates between scanning beams of light directed on photoelectric cells. The latter operate three signal lights, red, yellow, and green, indicating whether the ring meets specifications.

WIPER ARMS designed by the Anderson Company, of Gary, Ind., for use on military aircraft are said to hold blades securely under all conditions until a release lever is touched. The stainless-steel arms, currently available to civilian autoists, are adjustable for length and wiping pressure, and can be lifted out of the way when the windshield is cleaned. They will fit different types of wiper-motor shafts, a set of adapters being provided with each arm.



Will Tomorrow's Bus

**New Power for Motor Coaches
May Prevent Slow Movement
of Traffic on Long Hills**

WITHIN a few years motorists may find that buses are fully as agile as their own vehicles on long or steep hills and no longer slow pleasure cars behind them to a crawl.

That is one goal toward which advocates of twin-engine buses are working. The designers believe, in fact, that the greater horsepower and quicker acceleration obtainable with two engines eventually may become a necessity on some bus routes. Twin engines also offer interesting possibilities for interstate trucks, especially on long high-speed hauls of perishable freight.

Dual-engine motor coaches, of course, are not new, for a number have been in successful operation since 1927. But it now seems likely that they will come into wider use. Indicative of such a trend is a bus equipped with two medium-size engines that the Twin Coach Company, of Kent, Ohio, has developed. Designed especially for multi-engine power and mounted amidships under the floor, the engines operate independently, one furnishing power for each rear wheel.

Of 404 cu. in. displacement, each of the engines is rated 150 hp., two thus providing 300 hp. in all for the bus. In contrast, gasoline or Diesel engines now suitable for single installation in motor coaches develop only about 180 hp. A single engine yielding 300 hp. is considered impractical for use in a bus because its bulk and weight, concentrated in one spot, would take up badly needed space and necessitate a stronger and heavier frame.

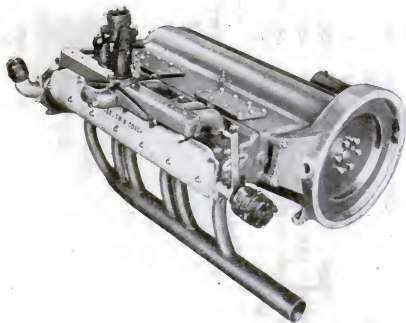
The Twin Coach engines rotate in the same direction. Thus they are readily interchangeable. Simply by reversing the cylinder block, and changing the overhead camshaft and cylinder head, one can be turned into either a right or left-hand engine. The intake manifold and carburetor are on the top side, the



exhaust manifold on bottom, and the spark plugs, valves, and distributor are toward the outer side of the coach in each case. Basically, the engine consists of three major parts, each of which is accessible for removal and overhauling independently of the others.

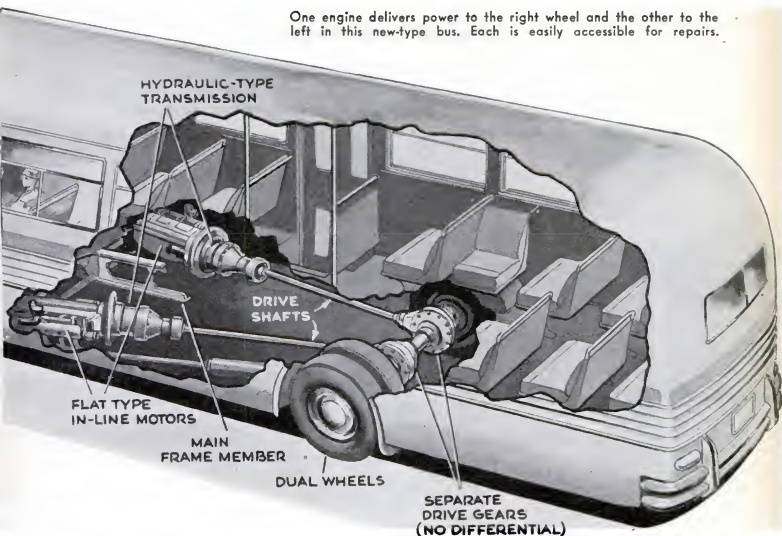
Fully equipped, the engines weigh 840 lb. each, or approximately 1,700 lb. for two—the average weight of the present single 180-hp.

Designed especially for use in a two-engine bus, this motor becomes either a right or left in-line type simply by reversing the block.



Have Twin Engines?

One engine delivers power to the right wheel and the other to the left in this new-type bus. Each is easily accessible for repairs.

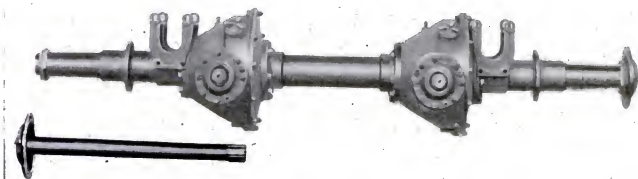


engine. For the same weight the horsepower is therefore almost doubled with two engines.

Since transmissions and rear axles for buses are currently being engineered for 175 to 180 hp., the use of a single 300-hp. motor would require a heavier and stronger design for these parts. But with twin en-

gines the load is so divided that standard units may be used, though the total power is almost doubled. Each engine has its own hydraulic torque converter, drive shaft, and hypoid drive gears. The two rear-wheel axles are entirely separate, and no differential is used.

Notice that the drive shafts are offset toward the same side because the two engines rotate in the same direction. There is no differential; the connection between the offset housings is merely for support.





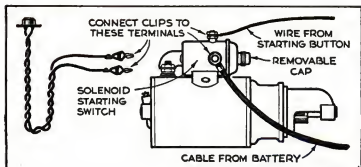
Style-conscious GI's give the hint to civilian drivers in designing jeep conversions that may soon adorn American roads.



FACE LIFTING of the snub-nosed and runty jeep, shown above in its familiar GI garb, results in the prettied-up version at left above. This jeep in mufti was turned out by mechanics at an Eighth Air Force bomber station in England who worked the transformation in their spare time, using only salvaged parts. The greenhouse job directly at the left is the product of air-minded GI's of the 644th Ordnance Depot on the Western Front. Modifications such as these could readily be produced in the postwar period for the modernization of existing surplus jeeps. While it is still uncertain if war-model jeeps will be manufactured in peacetime, the record of these sturdy little battle buggies will undoubtedly be a factor in light-car design.

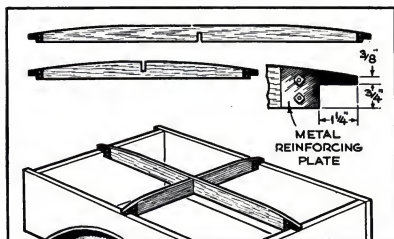
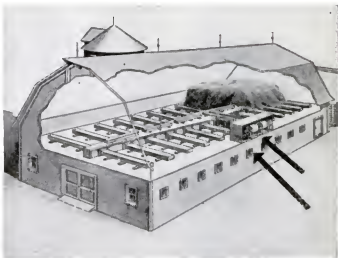


MECHANIC'S HELPERS being harder to come by than hens' molars, repairmen are often faced with the uncomfortable necessity of being in two places at once. Henry Lawrence, of Santa Fe, N. M., found it inconvenient to stop work and walk around to the starter button on the dash, or to the manual-operation button on the solenoid starting switch, whenever he wanted to turn the engine over during adjustment of the distributor or valves. So he attached a pair of spring clips to an 8' length of two-conductor wire, connected a pushbutton to the other end, and now has remote control of the starting motor wherever he may be working on the engine. It is connected as shown below.—E. S. HARRIS.





STORAGE OF HAY the same day you cut it is possible with a newly perfected barn-drying system announced by the General Electric Company, for you don't have to wait several days for the sun to cure it as in the past. The system consists of a motor-driven blower and air ducts placed on the floor of the loft or barn. Hay is piled on the ducts, and the air, driven through them by the blower, escapes through vents. A control developed by G-E permits either automatic or manual operation. Such a system virtually eliminates the danger of spontaneous combustion. Hay cured quickly in this way should bring higher prices, for it retains more of its nutritive value.



WATER RUNS OFF the canvas cover of a small trailer almost as quickly as it does off a duck's back if you use the rig at the left, reported in *Army Motors*. Two wooden braces provided with sloping upper edges and central notches are placed at right angles to each other so that they interlock and raise the center of the canvas. Water then drains off before it has time to soak through. Pieces of L-shaped metal may be bolted to the ends, as shown in the drawing, in order to protect the wood from splitting.

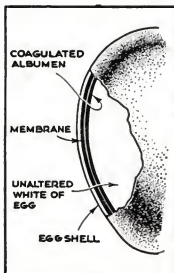
Eggs Are Preserved for a Year by Use of Flash Heat Treatment

EGGS remain in edible condition for as much as a year when given a flash heat treatment developed by Prof. Alexis L. Romanoff of Cornell University. The heat coagulates a very thin layer of outer albumen next to the shell, forming a thin inside coating that protects the contents.

Suitable for either home or commercial use and requiring only average kitchen equipment, the treatment consists of plunging the eggs into boiling water for five seconds, letting them cool, and putting them in a refrigerator. Prof. Romanoff found that eggs so treated still were in good condition a year later when kept in a refrigerator at 41 deg. F. Even when stored at room temperature of 70 deg. they stayed good for three months. In contrast, untreated cold-storage eggs as a rule re-

main edible for only about six months.

Fertile eggs hatch after the treatment, indicating that the nutritive value, flavor, and cooking characteristics are unimpaired. The stiffness of the albumen after beating, usually considered a criterion of storage eggs, is just about as good as that of fresh eggs.





Magnetic Checkers Stay Put on Vertical Board

A GAME that started out as an engineer's pastime has proved to be a boon to bedridden soldiers. While experimenting with novel uses of alnico, a magnetic alloy, Joseph Scardino of the General Electric Company turned up with this ingenious checker game. It consists of a set of ordinary checkers fitted with small magnets which hold them in place on a sheet-steel board painted off into squares. To provide an attraction between checkers when kings are wanted, a small metal disk is cemented to the top of each checker. Scardino presented the outfit to the Halloran General Hospital in New York. Since the game can be played without disturbing a patient's posi-

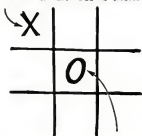


tion in bed, the occupational-therapy department of the hospital is having additional sets made as the required materials are obtained. Magnetic checkers have proved popular with hospitalized soldiers.

Maybe You Won't Win, But You Just Can't Lose

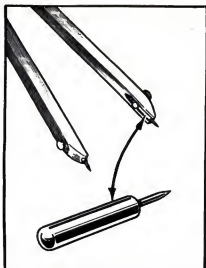
PLAYERS not practiced in the game sometimes find ticktacktoe exasperating because it so frequently ends in a draw. But when experts play, it always ends that way! The player who opens in a corner has the best chance to win, but the second player can't lose if he responds by moving into the center square and then avoids corners. If both players know this trick, every game will end in a draw unless they establish rules prohibiting this opening.—E. S.

FIRST PLAYER USES CORNERS



SECOND PLAYER AVOIDS CORNERS

POPULAR SCIENCE

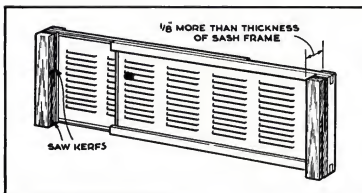
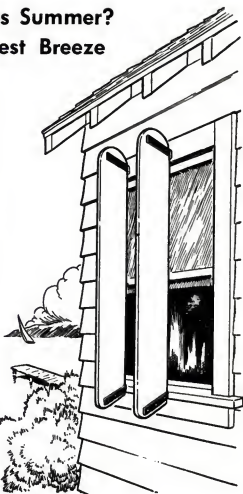


Phonograph Needle Used in Dividers

REMOVABLE divider points that blunt or break can be replaced by old phonograph needles, and some compasses can be converted into dividers by substituting a needle for the pencil. The needles will remain sharp a long time.—H. SAMUELS.

No Electric Fan This Summer? Harness the Nearest Breeze

EVEN in the dim, forgotten days when electric fans could be had, they still had a price. But then, as now, the wind was free. This wind deflector takes advantage of the fact that every latitude has its major directional breeze which blows most of the time from one point of the compass. If your house is hot while your next-door neighbor's is relatively cool, the chances are that your windows run parallel to, instead of across, the direction of the wind. Deflectors or vanes, made of waterproof plywood or similar material and mounted on angle brackets as shown, will turn the fleeting breeze in upon you.—B. M.

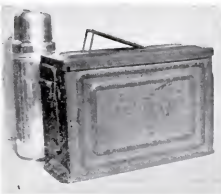


Two Wood Blocks Suppress Rattles in Ventilators

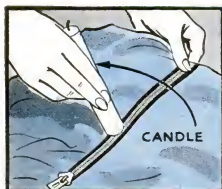
WINDOW ventilators that rattle persistently can be toned down a comfortable number of decibels by gluing on kerfed blocks of the size and shape indicated at the left. Kerfs bandsawed from both ends and overlapping about an inch at the center will give the necessary spring action for a secure fit.—DANA S. GREENLAW.

Army Ammunition Boxes Make Versatile Home-Front Servants

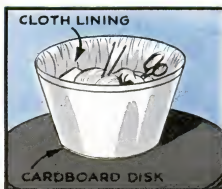
WITH metal containers either exorbitantly priced, unavailable, or unsatisfactory, I have found welded ammunition cartons on sale at some stores to be useful substitutes for a number of household articles. Each box has a folding handle, shoulder-strap buckles, and a latch for a padlock. It is useful as a lunch box, a fire-resistant chest for money and valuables, a case for camera accessories, or a small tool kit. I converted one of them into a mailbox better than I could have bought at three times the price.—M. REYES.



KEEPING THE HOME



If zippers develop a tendency to stick or jam, you can ease their operation and prolong their life by rubbing them with a wax candle.



A roomy sewing basket can be made out of an old lampshade by pasting a cardboard disk to the bottom and sewing in a sturdy fabric lining.

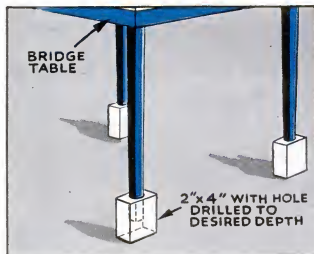


Hot pies will cool more quickly if placed on top of a colander. The perforations allow cooling air to flow underneath as well as on top.

When in doubt as to whether a second postage stamp is needed for a letter heavier than usual, you can improvise a surprisingly accurate postal scale by balancing a foot rule across a hexagonal pencil. Place the scale on a flat surface, and use two half dollars or four quarters as weights. Center them over the 2" mark, the letter on the 10" mark. For 1/2-oz. air mail to overseas service men, use two quarters or one half.

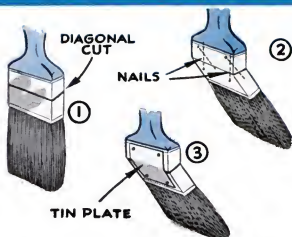


At your next party or club meeting, you'll find it helpful to try this method of keeping coats and hats together without confusion. A spring-type clothespin, fitted with a screw hook, holds the hat neatly to the trouser bar of the hanger.

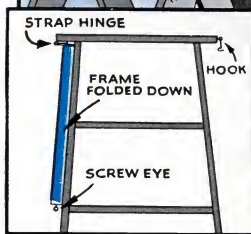


Extra dinner guests will sit more comfortably at a bridge table raised to regular table height. A set of wooden blocks bored to take the legs will elevate the table to the correct height.

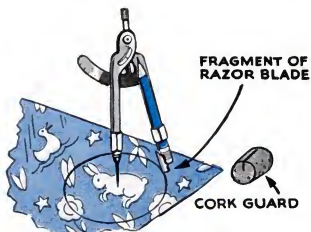
SHIPSHAPE



Inaccessible corners behind pipes or fixtures can be cleanly painted with the aid of a curved paintbrush. Saw diagonally through the arm, reverse the pieces, and toe-nail them together. Add a piece of tin-can metal as reinforcement.



Tools and equipment can be prevented from rolling off the top of a stepladder by a railing that can be swung on or off as needed. Hinged at the edge so that it can be folded back along the leg, the frame does not interfere with use of the top step.

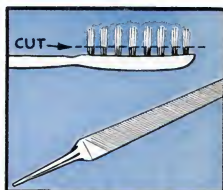
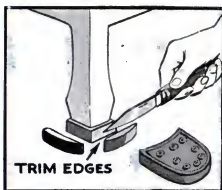
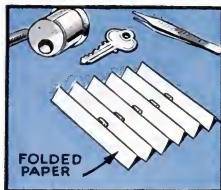


Adapting an ordinary compass for cutting perfect circles requires only a metal-headed pencil and a sliver of razor steel. Solder the blade fragment to the pencil head with about $\frac{1}{4}$ " of the sharpened edge projecting, and use as you would a compass.

When repairing tumbler locks, it is essential to replace the pins in correct sequence. Instead of relying on memory, keep the parts in order in a folded paper tray.

Heavy kitchen fixtures need not scratch or break the linoleum if rubber-heel cushions are inserted under each leg and trimmed to project very slightly on all sides.

File teeth can be cleaned with the same kind of brush you use on your own teeth. Trim the bristles of a discarded brush to about $\frac{1}{4}$ " from the base to obtain a stiff surface.





HOME OWNERS



CORK-FILLED TAPE designed to stop condensation drip from cold-water pipes has been introduced by the J. W. Mortell Co., of Kankakee, Ill. Pliable and easily applied, it forms a snug jacket around pipes, fittings, and valves. Brown in color, the tape can be painted if desired. It comes in a coil sufficient to cover 7' of $\frac{1}{2}$ " pipe, and no tools need be used for installing it.

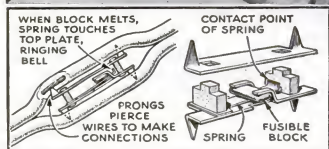
WOOD PLASTIC developed by the So-Lo Works, Inc., of Loveland, Ohio, can be handled like wood itself—sawed, planed, and finished in any color desired. According to the maker, it is waterproof, shrinks little, and keeps soft and workable for years. It is available in $\frac{1}{8}$ and 1-lb. jars or in 5-gal. and drum sizes.



SHADOWLESS LIGHT is provided for the bathroom mirror above by a circular fluorescent lamp hidden from head-on view in a reflector. Finished in a dull white color, the lining of the reflector distributes the light evenly on the face and neck. The lamp was designed by the illuminating engineering department of the Westinghouse Lamp Division, at Bloomfield, N. J.



LOW-COST FIRE ALARM. Automatic heat-sensitive units spaced at 10' intervals in a flexible wire form the basis of the Warner Home Fire Alarm, made in Glen Ridge, N. J., by the Millwood Products Co. When any unit is subjected to heat of 150 deg. F., a fusible block melts and automatically closes a circuit, ringing a gong. The system is sold for installation by the purchaser, complete with bell, transformer, insulated staples, and instructions. It can be quickly installed along baseboards and moldings. Millwood Products is a unit of Junior Achievement, an organization intended to give teen-agers a practical chance to learn about business at first hand.



ARCHAIC WEAPONS still have a place in modern war, as evidenced by the crossbow grenade thrower at right. The device was welded together by T/4 Alan J. Hamm of the 26th Infantry. Note the two-handed crank for cocking the bow.

JEWEL-LIKE PLASTIC forms the glittering coach shown below. It was fashioned by Emile Norman, of El Monte, Calif., from gray, frosty white, and clear plastics. The coach has a removable top and holds a container for flowers. Norman also makes one-of-a-kind lamps, ornaments, and picture frames of plastics.



**MADE BY
AMERICAN
CRAFTSMEN**

INTEREST COMPOUNDED with skill as a craftsman enabled San Francisco banker Howard Whittle to turn out these meticulously finished projects of rare wood. Using mainly a lathe and a bandsaw, he has applied many features of the metalworker's art to his wood creations. Note the delicate designs in the plates and jewelry below, some of which utilize as many as 660 pieces of wood from all over the world.



PLANE BUILDING is almost an around-the-clock job for Edward Soltis, whose brother is a bombardier on a B-29 Superfortress. As a metal fitter in the Eastern Aircraft plant at Tarrytown, N. Y., he helps produce real planes. A deaf mute since a childhood illness, Soltis builds models in his spare time. Using pictures and magazine illustrations, he drew up his own plans for the Avenger torpedo plane above, scaling the drawings to give it a 28" wingspread, and then devoted 150 hours to its actual construction. Features of his model include a functioning bomb bay, wing slots and flaps, gun turret, machine guns, landing lights, retractable landing gear, and a model torpedo.





One method of launching the plane is to push it into a glide while piercing the gas chamber as shown at the left. Below, the carbon dioxide cylinder is being placed in the cockpit housing.



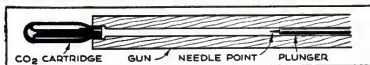
The gun fits the neck of the cartridge, and a pin in the barrel shoots forward to puncture the seal.

Carbon Dioxide Gas Cartridge Powers Model Jet Plane

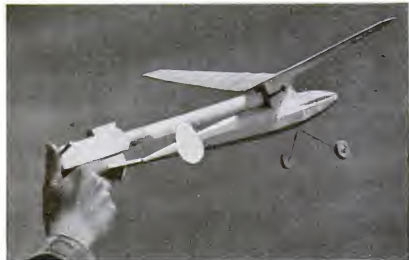
NEVER far behind the aircraft industry, model-plane enthusiasts are losing little time in getting acquainted with jet propulsion. For those who want to study the technique before designing original craft, commercial kits are available similar to the one used in constructing the model jet plane shown on this page.

Jet action is obtained through the use of carbon dioxide cartridges of the type used to inflate life rafts. Since Army-Navy standards run high, the rejects available for powering the jet planes pack plenty of punch. Even more important, CO₂ is completely harmless and therefore a safe jet propellant for beginners. Because the weight of the gas chamber changes while the gas is being discharged, it is mounted in such a position that it will not affect the plane's center of gravity.

Michele de Santis, Jr., of Bayside, N. Y., shows how to load and launch the plane. A needle in the gun, as in the drawing at the right, pierces the cartridge seal. Aircraft Products Co., makers of the kit, also manufacture the gun.



As the cartridge neck is held firmly in the gun barrel, the firing pin is sure to strike it squarely. This impact helps the plane take off before the jet stream goes into action.

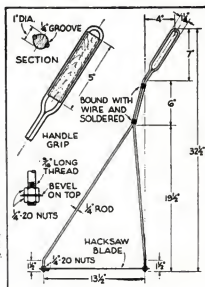
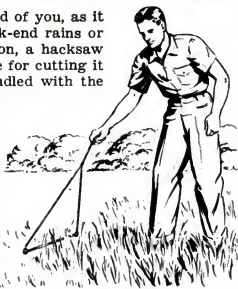


Ground Hacksaw Blade in Frame Cuts Back Neglected Grass

WHEN your lawn gets ahead of you, as it might during a series of week-end rains or while you are on your vacation, a hacksaw blade can come to your rescue for cutting it down to where it can be handled with the lawn mower. The blade should be one that is hardened all the way through so it can be ground sharp on both edges. Held in a frame bent from $\frac{1}{4}$ " soft steel rod, it cuts on both the forward and backward stroke.

Enlarge the holes in the ends of the blade with a punch, if you have one, or drill them out after softening the ends by heating to a cherry red and letting them cool in air. Thread the frame, as indicated, and secure the blade between nuts.

Leave the handle open, or groove and shape a piece of wood as shown and fit it in

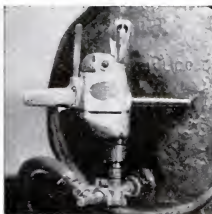


place before binding the frame with wire. Dimensions may be changed to suit any size blade. The handle should be long enough to make stooping unnecessary.—A. BOHN.

Electric Drill Powers Pump For Moving Liquids from Drum

POWERED by a $\frac{1}{2}$ " electric drill operating at 400 r.p.m., a discarded $\frac{1}{2}$ " rotary-type marine water pump is used in the Sun-Journal pressroom at New Bern, N. C., to

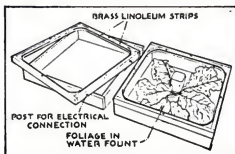
fill press fountains with printer's ink from drums. The drill is mounted on the drive shaft of the pump, as shown in photos at left. All fittings are standard, those for the pump being $\frac{1}{2}$ ". The hose used to carry the ink from the pump is $\frac{3}{4}$ ", however, in order to keep the flow free. This rig is far superior to the hand pump previously used.



Such a device should also be able to handle any oil or grease light enough to flow into the intake of the pump. If hose longer than 8' is used, or the fluid is heavy, a larger diameter may help to relieve back pressure.—HUBERT E. JONES.

ELECTRIC FENCES in miniature are used by entomologists at the Du Pont Pest Control Research Laboratory at Wilmington, Del., to keep crawling insects within bounds. The insects, large numbers of which are used in experiments, are given the freedom of open, panlike boxes containing growing plants on which they feed. Around the rim of the boxes are two of the narrow metal strips normally used on linoleum. Wires carrying low-voltage

electricity are attached to the strips, making a barrier similar in effect to electric fences on farms. Wandering insects that crawl up the inside walls of the box come into contact with the electrified strips. This isn't fatal, but it is discouraging.



Even Novice Carpenters Can Improve
Their Living Quarters at Low Cost

HAMMER-AND-SAW UNIT FURNITURE

YOU MAY be like many other Americans these days—living in an apartment or room which lacks the furniture you need to make it comfortable. But you don't need to despair if you can borrow a hammer and saw; and don't think that you have to spend a lot of money. Here are three smart and functional pieces of furniture: an end table, a bookcase, and a lamp, all born of a designer's need for such items in his wartime home. Your own ingenuity may add some new touches.

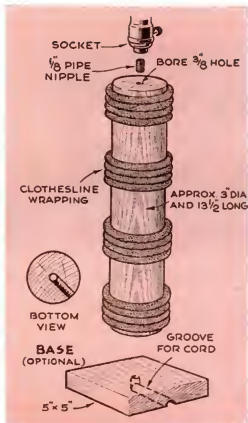
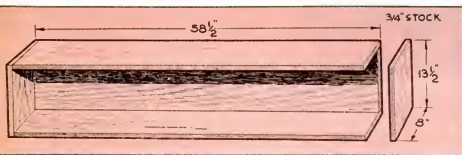
The lamp upright is nothing more than a section from one of the wooden poles placed inside rugs when they are rolled for shipment from the factory to stores. Usually these are 'thrown away or sold as junk. A hardwood rolling pin might also be used. Cut a suitable length from the pole and bore a center hole for the cord, working from both ends toward the center. (If you use a rolling pin, you may find it is already provided with a hole.) The decorative wrapping is simply a piece of clothesline, dipped in dye, if you wish, to match a room color.

Essentially, the bookcase is just a rectangular box. But if attractively finished, it can be used to good advantage over a couch, desk, or any long wall space. Long screws should be used to secure it to the studs within the wall. Bric-a-brac as well as books will find display space on the shelves.

The end table will fit almost any surroundings, depending on the care put into its finish. Ordinary pine



You'll take pride in displaying this decorative and inexpensive lamp. Its round base was cut from a rug pole.



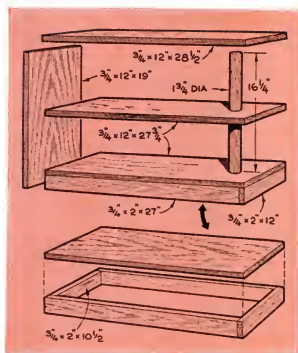
This bookshelf is nothing more than a rectangular box. But you may find it useful in several spots—above a couch, a desk, or on some wide wall space, particularly if it is given a colorful finish. Bric-a-brac placed beside the books lends added charm.



Given a good finish, this attractive end table should find a useful place among the furnishings of your home.



Several smart combinations are possible if you make two of the tables. Place them end to end beneath a window, as above, or in front of a couch as a handy place to keep books and magazines.



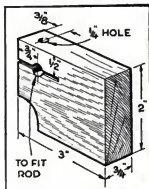
lumber, 12" wide, was used for the tables illustrated. The dimensions indicated can be adjusted to individual requirements, of course, and a square post can be substituted, if you wish, for the round one which joins the top and bottom shelves. If locating and cutting the hole in the center shelf seems too much trouble, the post can be made of two pieces. To make a smooth job, use finishing nails, countersink them, and fill the holes with putty.

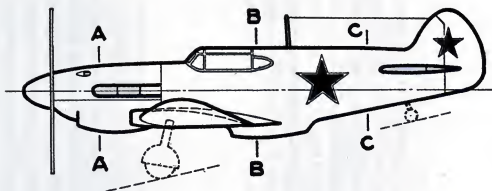
To a great extent, the finish will determine the ultimate satisfaction or dissatisfaction you will feel with your handiwork. Hence, a little extra work at this stage to make certain that the table has a handsome appearance will pay dividends.

After sanding the piece extensively with several grades of progressively finer paper, give it the finish that will fit best in the room. One possibility is to use white or ivory enamel and apply colorful decalcomanias. The result should be particularly appropriate for a modern apartment. Two tables will make possible several smart and useful combinations.—JAN AND JACK HOLMES.

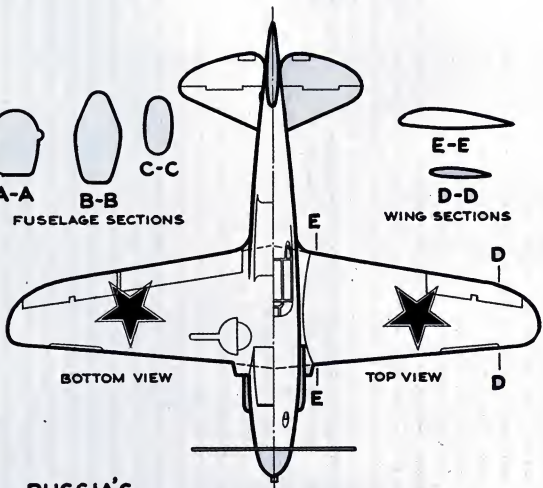
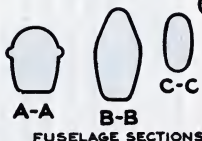
IDENTICAL LENGTHS of wood can be cut with ease on a circular saw if you use this jig, a steel curtain rod or piece of Bessemer rod, 24" to 36" long, equipped with an adjustable stop block. The rod fits into the usual stop-rod hole in the miter gauge. Quickly adjusted at any distance on the rod, the block is locked in position with a bolt and wing nut. The dimensions given for the block should fit most circular saws.

—FRANK HEGEMEYER.



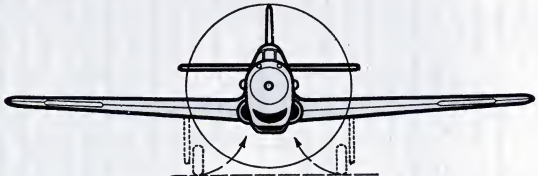


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**RUSSIA'S
LAGG 3**

**PLANS ARE
HALF SIZE**



-PATRICK-

MODELING RUSSIA'S LAGG 3 FIGHTER



CONSIDERING the number of aircraft designs experimented with by all belligerents and the high rate of obsolescence of planes tested in action, the quality of the Red Air Fleet's Lagg 3 can best be described by the statement that it hasn't yet worn out. A stand-by throughout the entire European war, this fighter covered every Russian front and everywhere proved itself an expensive visitor for the foe.

Russia's shortage of metal and metal workers made it necessary to employ a composite wood-and-metal construction. A 1,200-hp. liquid-cooled engine gives the Lagg 3 a speed of about 350 m.p.h. Its armament consists of a single 20-mm. cannon in the nose and two 12.7-mm. machine guns. The plane is 29' long and has a wing span of 32'.

Because of its trim lines, modeling this plane presents no unusual problems for the craftsman. Balsa or white pine may be used equally well, and the choice depends only on availability and preference. A block of about 1" by 2" by 7" is needed for the fuselage. First draw the profile on the block and cut away the excess wood; repeat this process for the top view; and then carefully carve and sand it down to the shape called for in the drawing.

The wing should be made of another single piece. Cut a corresponding notch in the bottom of the fuselage to receive the wing and then glue it in place. Fill in the crevices with plastic composition wood. The left-hand side of the center drawing gives a bottom view

Veteran of the entire war, Russia's Lagg 3 ranks among the deadliest fighters of the Allied fleets.

of this construction. Tail surfaces, formed separately, should be shaped as shown.

Assemble the entire model before painting. Apply several coats of wood filler and sand between each coat with wet-or-dry sandpaper. The model illustrated below was given two coats of green-brown airplane dope on the upper surface and two coats of sky blue underneath. Decals of the Russian insignia were purchased at a hobby store. A whirling propeller effect is obtained by gluing a celluloid disk behind the propeller spinner. The cockpit is painted white with a fine-line black trim. All control-surface effects are obtained with thin black lines.

Proper mounting of plane models is important to the appearance of your collection. The sharp angle of this one gives an impression of flight and action.



BANTAM-SIZE FARM WAGON

Familiar Old Standby Is Scaled Down to Make a Sturdy Coaster Wagon

By EDWIN M. LOVE

HAPPY memories of days down on the farm are called to mind by this toy wagon. Easy rolling and a good coaster, it can be steered by a child with his feet; yet it is a big, husky wagon capable of hauling almost any load that can be piled on it.

As in a full-size wagon, the reach twists and permits the wheels to drop individually into ruts, but this action is restricted somewhat by the box, which has not been made flexible. The running gear is built of oak, but pine or other soft wood is suitable for the box and seat. Iron rods, which need not be of the exact sizes specified, can be picked up at a dump or wrecking yard. Mending plates and angles are sold at hardware stores.

Bandsaw the wheel-felloe segments from stock at least 1/16" thicker than the finished felloes to allow for truing after assembly. Rip the spokes on a taper jig and smooth them on a sanding disk or belt before rounding the corners. Sand also the tapered ends that enter the hub mortises. The round tenons are cut with a jig and dado head.

Turn the four hubs in one piece; then, before cutting them to length, scribe pencil lines to locate the mortise ends, noting that alternate spokes are staggered 1/4". Use the index attachment of the lathe to space

the mortises. Bore two holes for each mortise and trim it to shape with a chisel. Then bore the hubs and true the ends with the aid of a wooden chuck turned to fit.

Make a trial assembly of each wheel before gluing. Put the spokes in the hub first, chamfering the ends if necessary to prevent interference when they are driven to bring the shoulders to correct distance from the hub. Number the spokes and their mortises and take them apart. Then glue the tenons into the felloe segments with plastic glue. In this way the shoulders can be driven up tight with little trouble.

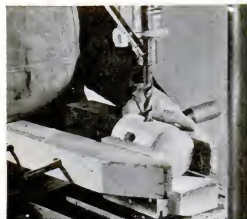
Next, make an assembly jig by cutting a hole in a flat board to fit a hub, which is inserted outer-end down. Start the spokes into the hub by springing the free ends apart, and then drive the segments until they line up at equal distance from the hub with their ends touching. Place 1/4" shims under the upper spokes at the hub and clamp the segments to the jig. True the joints by cutting through with a backsaw, and then drive the spokes a little farther into the hub. If the segments are still too far from the hub, cut the joints again. When the fits are accurate, take the wheel apart, apply glue, and reassemble with the spokes shimmed to assure dishing of the wheel. Be sure that the felloe splines are short enough to enter without spreading the joints.



Wheels for this toy farm wagon are sawed out in sections. At left, segments that form the felloes are slotted for splines before being trued up.



Round tenons required on the outer ends of the spokes are shaped in a jig with a dado head, as at the right.



Rectangular mortises in the hubs receive tapered ends of the spokes. An L-jig of pieces nailed up and clamped holds the hub in the drill press.



This jig is also of use when the drilled mortises are chiseled to shape, as shown at the right. Note the slight staggering of alternate mortises.



Clamp the felloe to the board and check squareness by resting a straightedge on the end of the hub and measuring the distance of the ends from the board. If one end is higher than the other, the hub leans and should be straightened with a clamp.

Bore the bushing blanks to fit the spindles, turn a slightly tapered rod for a mandrel on which to slip the blanks for turning their outside to a light driving fit in the hub, and mark the blanks for identification. The bushings should be soaked in lubricating oil or boiled in it before they are driven in.

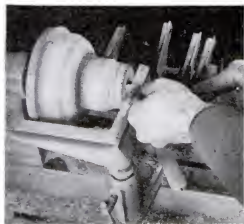
When the wheels are dry, mount them on a pivot jig and true the edges with a shaper or sander. Drive glue-coated wedges into the mortises where they are open.

Attach rubber-belt tires to the wheels with bicycle-tire cement, securing the ends with a couple of brads. After some use the tires may stretch and come off, and they will

have to be shortened and recemented. When the tires have been broken in, a few brads driven around the circumference will reinforce the cement. If you wish, you may glue a strip of heavy cloth to the wheel with plastic glue and then glue the tire to the cloth with rubber cement. Better, of course, are iron tires shrunk on while hot.

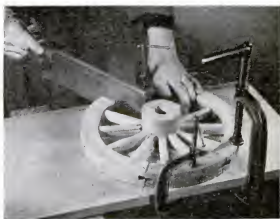
True the axle bearing surfaces by filing the $\frac{1}{2}$ " pipe in a lathe operated at its lowest speed. Turn a wooden chuck to drive the axle, ream the burr at the ends, and support the tailstock end with a metal-turning center. Use a flat mill file, keeping the teeth clean. Crown the axles by supporting them on blocks behind the spindles and pounding the centers with a hammer.

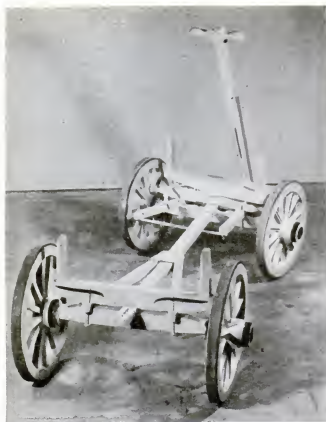
Flatten the strap sections of the U-bolts by cold hammering, being sure to measure them as they are worked, for the metal will stretch. If no threading die is at hand, bend



When boring the hubs for the axle, hold them one at a time in a wooden chuck turned to fit. The ends of each are trued before it's taken from the chuck.

Felloe joints can be trued, as at right, by sawing through them during a trial assembly and driving the segments tight.





In the assembled running gear, the relationship of parts detailed in the drawing is shown. Circle irons and sway bars take stress off the kingbolt.

⚡ Sway bars and irons show clearly at the left, as do adjustment holes in the rear end of the reach.

the bolts to fit their positions and rivet the ends over the yoke plates. Bend the ends of the circle irons and curve them a little at a time throughout their length by placing them on blocks 3" apart and hammering between the supports. Turn up the ends to fit the hounds.

Cement washers to the ends of the axletrees and hubs before mounting the wheels. The washers may be enlarged, if necessary, by filing out the holes. Smear the spindles and bushings with graphite grease or, if desired, the hubs can be bored and fitted with

grease-gun attachments to eliminate the bother of removing wheels for lubrication.

The running gear can be shortened by sliding the reach farther through the hind carriage and shifting the hind sill forward correspondingly. This shortens the turning radius and eases steering in coasting by throwing more weight on the hind wheels, but it increases the tendency to lift the front when pulling loads.

If spoke wheels require too much work, disks cut from plywood or stock glued up from $\frac{3}{8}$ " lumber, as shown in a drawing, can be substituted. Make the hubs in two sections, assemble them on bushings, and join them with glue and long screws.

Finish the wagon with two coats of enamel, making the running gear yellow and the box and seat orange and red.

LIST OF MATERIALS

No. Pc.	Description	Stock	T	W	L	No. Pc.	Description	Stock	T	W	L
12	Front felloes	Oak	1 $\frac{1}{4}$	1 $\frac{1}{4}$	6 $\frac{1}{4}$	1	Reach	Oak	$\frac{3}{4}$	1 $\frac{3}{8}$	43 $\frac{1}{2}$
12	Rear "	"	1 $\frac{1}{4}$	1 $\frac{1}{4}$	7 $\frac{1}{4}$	2	Hind hounds	"	$\frac{7}{8}$	1	19
24	Spines	"	$\frac{3}{8}$	1 $\frac{3}{8}$	1 $\frac{3}{8}$	2	Gussets	Plywood	$\frac{1}{8}$ (to suit)		3 $\frac{1}{2}$
24	Front spokes	"	$\frac{3}{8}$	$\frac{7}{8}$	5 $\frac{1}{8}$	2	Front hounds	Oak	$\frac{7}{8}$	1	15
24	Rear "	"	$\frac{3}{8}$	$\frac{7}{8}$	6 $\frac{1}{8}$	1	Tongue hound	Plywood	$\frac{3}{4}$	$\frac{7}{8}$	8
4	Hubs	"	3 diameter		4 $\frac{1}{4}$	1	Doubletree	Oak	$\frac{3}{4}$	1 $\frac{1}{2}$	16
4	Hub bushings	"	1 $\frac{1}{4}$	"	3 $\frac{3}{8}$	1	Tongue	"	$\frac{3}{4}$	1 $\frac{3}{8}$	28
2	Axles	Black-iron pipe	$\frac{1}{2}$	"	24	1	Handle	"	$\frac{3}{4}$	1 $\frac{1}{2}$	7 $\frac{1}{2}$
1	Front axletree	Oak	1 $\frac{3}{8}$	1 $\frac{7}{8}$	15 $\frac{1}{4}$	2	Sills	"	1	3	16
1	Sandboard	"	1 $\frac{3}{8}$	1 $\frac{3}{8}$	16	1	Box-floor stiffener	Pine	1	3	14
1	Front bolster	"	1 $\frac{3}{8}$	1 $\frac{1}{2}$	17 $\frac{1}{2}$	5	Box flooring	"	1	3	43
8	Mending plates	Iron	$\frac{1}{2}$	$\frac{3}{4}$	3	2	" sides	"	$\frac{3}{8}$	6	43
4	" "	"	$\frac{1}{2}$	$\frac{5}{8}$	2	2	" ends	"	$\frac{3}{8}$	6	13 $\frac{1}{4}$
2	Sand plates	"	$\frac{1}{8}$	1 $\frac{3}{4}$	4 $\frac{1}{2}$	2	Seat supports	"	$\frac{3}{8}$	4 $\frac{1}{4}$	8
1	Kingbolt	Steel	$\frac{3}{8}$ diameter		6	4	Mending plates	Iron	$\frac{1}{2}$	$\frac{3}{4}$	3
4	S'aks	Oak	$\frac{3}{4}$	$\frac{3}{4}$	6 $\frac{3}{8}$	1	Seat	Pine	1	7 $\frac{1}{2}$	15 $\frac{1}{2}$
1	Hind axletree	"	1 $\frac{3}{8}$	1 $\frac{7}{8}$	15 $\frac{1}{4}$	2	" sides	"	1	4	8 $\frac{1}{2}$
1	" bolster	"	1 $\frac{3}{8}$	2 $\frac{1}{4}$	17 $\frac{1}{2}$	1	" back	"	1	4	17 $\frac{1}{2}$

Miscellaneous: 8 washers, 4 reducing washers, 4 cotter pins, 11 steel bolts (3/16" by 1 $\frac{1}{4}$ "), 3 steel bolts (3/16" by 2"), 4 U-bolts, 4 yoke plates, 2 sway bars, 2 circle irons, 1 T-hinge (3"), 2 rub irons, 2 shelf brackets, wood screws, and roundhead machine screws.

Note: All dimensions are given in inches and are finished sizes.

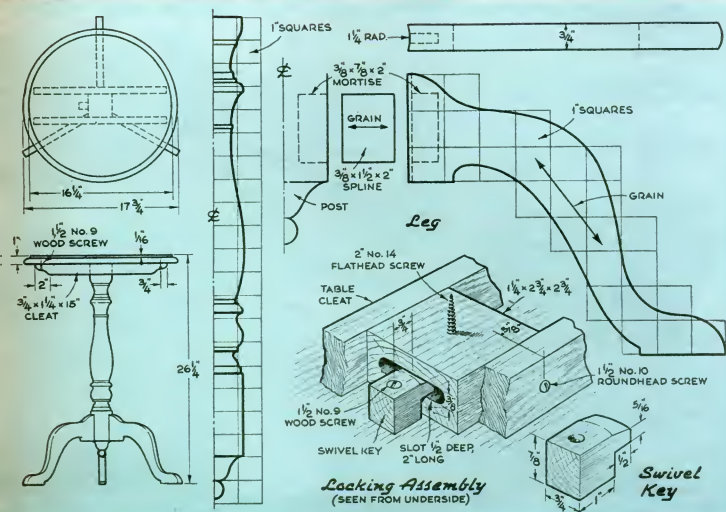
CHIPPENDALE TILT-TOP TABLE

By Norbert Engels

THOMAS CHIPPENDALE, eighteenth-century master, is usually thought of as ornamenting his furniture with elaborate carvings, but I have found this simpler style, with some few adaptations, particularly suitable for the modern American home. Missing besides flutings and carvings on the post and feet are the piecrust table top with its dished-out effect and the intricate "cage" tilting device which has here been replaced with a less intricate unit.

Most characteristic of the Chippendale school is the form of the tripod legs, a cyma curve or ogee as distinguished from the comparatively "hollow" designs of the Sheraton and Duncan Phyfe styles. Such a splayed tripod base was originally intended to let a table rest steadily on the uneven floors of the period.

The legs are shaped to fit against the post by having their contact surfaces hollowed against a sanding drum of the same diameter as the post. This drum can be turned in the lathe, and the sanding may be done by



sliding the mortised leg along the tool rest. The legs are assembled with splines as in the drawing and are secured by gluing under clamp pressure. If a joint does not seem tight enough, a dowel may also be driven in at an angle for additional strength.

One of the drawings shows the tilting and locking device in an upside-down position.

Two cleats are screwed to the bottom of the top, and a square block, which will move easily between them, is screwed to the post. For a hinge two screws are driven through the cleats into the block exactly opposite each other but off-center in the block. They should not be too tight in the cleats. A swivel key locks the table top.

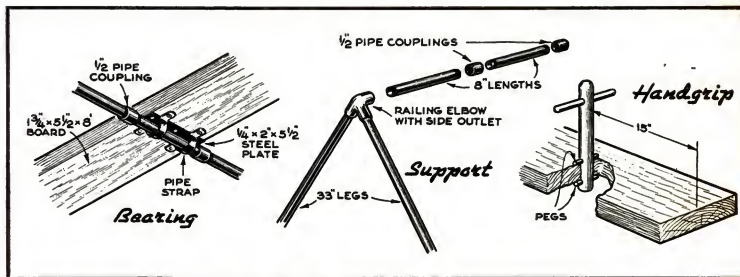
Back-Yard Seesaw with Pipe Support Is Safe for Small Children

UNWELCOME spills are next to impossible on a safety seesaw held to its fulcrum with pipe straps and fitted with upright handles to which even the littlest tots can cling while riding up and down with the board. The assembly is so light that two children can move it around to suit their fancy.

Short lengths of pipe assembled with two side-outlet elbows and two couplings that prevent side slippage form the fulcrum. The bearing is made with a steel plate and two pipe straps, as shown in the drawing. It can be attached to the teeter board either at the center, if the children are nearly the same weight, or off-center for those whose size differs greatly.

The hand-grip uprights may be large doweling or square stock rounded by plane or in the lathe and held with pegs.

—KENDRICK M. MARTIN.



C-Clamp Serves as Handle for Hand-Scraper Blade

DRAWN tight on a hand-scraper blade, a large C-clamp provides an excellent grip. You may even find it takes greater pressures, makes smoother strokes, and is less fatiguing than some of the handles devised for the purpose.—R. M. WOODBURY.



With the first gusts of an approaching squall, these becalmed sailboats nose automatically into the wind, the result of sufficient weather helm.

Another advantage of weather helm is evident in working to windward, as with the craft shown at the left. Moderate weather helm is always a big help, but too much can make sailing a nuisance.

SAILING BALANCE...SAFETY VALVE

IF YOU HAVE TO FIGHT THE TILLER, YOUR BOAT LACKS BALANCE

By Elon Jessup

WHAT your sailboat does when you let the tiller swing free goes far to show whether she's a safe or a risky craft. If the boat noses directly into the wind when you release the tiller, then you have little to fear, for a sudden gust will turn your bow to face it and the next gust can't catch you broadside. But if you are kept constantly fighting to head toward the wind, you are in danger of having your bow turn leeward the minute you let the rudder swing free or lose steerageway, and there real trouble begins.

In the first instance, your boat is probably properly balanced; in the second, it is decidedly not. A boat that noses automatically into the eye of the wind is said to possess weather helm and, no matter what else may be wrong, it is at least safe in this regard. One that heads the other way has lee helm, and this—except with

planing racing scows—is always a disadvantage. Corrections can be made for lee helm, as they can also be for excessive weather helm.

Too much weather helm makes steering difficult and checks progress; it makes you battle continually to keep the boat from coming into the wind and takes the fun out of sailing. All you need is just enough weather helm and no more. A mere touch on the tiller should be sufficient to keep you on your course, but at the same time you should be able to count on your boat heading into the wind automatically whenever you are forced by some necessary task to let the tiller go. In addition to being dangerous, lee helm also takes the joy out of sailing. It keeps you constantly pressing the tiller to stay on your course.

Balance is the perfect working relationship between sails and hull. When a boat has either lee helm or excessive weather helm, it means the hull and sails are out of



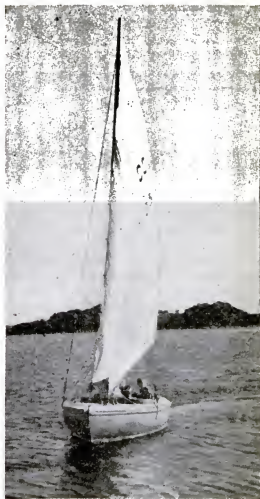
Originally the rudder of the Mae Win shown above ranged high above water, as does the same "barn-door" type on the Tad at right. But while this was fine for the Tad, as indicated by the gentle touch on the tiller, a better balance was achieved for the Mae Win by lowering the rudder and passing the tiller through a hole in the transom.



OF YOUR BOAT

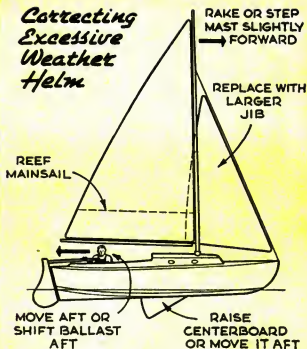
balance. This is clearer when you understand that the hull has a center of lateral resistance, commonly abbreviated CLR, and the sails a center of effort, called CE. The former is the center of resistance against the sideways movement of the hull through the water; the latter is the center of effort made by the wind against the sails. Balance combines resistance against water with utilization of the force of the wind.

The center of lateral resistance is located somewhere amidships in the lower part of the hull. Theoretically neither the bow nor the stern would turn if you made a line fast at this point and then hauled away. Actually the point is subject to constant change depending upon the heel of the boat, her speed, the size of the waves, and many other factors. Theoretically the center of effort is located on a triangular sail at the intersection of lines run from any two corners to the center of the opposite sides. Actually it also is subject to shift, for a sail doesn't remain for long in any given position and



When a sailboat promptly heads up into the wind with its rudder swinging free, it can be rated as a safe boat. This is the effect of balance in relationship of hull and sails.

Correcting Excessive Weather Helm



it heels with the breeze at varying angles.

But every boat starts with a definite plan, and yours, if it was designed by a competent naval architect, was built and rigged with a specific if somewhat theoretical relationship between CLR and CE that should work best for that particular boat.

It is customary to place the CE forward of the CLR, usually 3 to 10 percent of the lead waterline length depending on the hull and the type of rig. If the CE is too far forward, you get lee helm; if the lead isn't enough, excessive weather helm results.

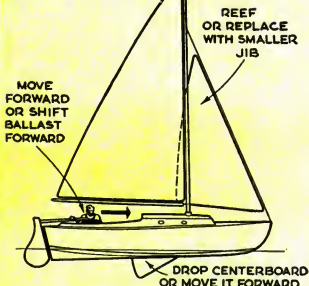
You'll know soon enough by the amount of work required in sailing whether performance is the best that can be expected. If it isn't, you'll want to know why. Assuming your boat was designed correctly, you can probably trace poor performance to a change in the original rig, such as from gaff to jibhead. Liberties taken with the keel or in changing to a different kind of rudder can also upset balance.

Logical cures are suggested in the drawings above. If you have excessive weather helm, move the center of effort forward. One way to do this is to shorten the mainsail by reefing. Another is to hoist a larger headsail. Still another is to move or tilt the mast slightly forward.

Lee helm is corrected similarly by moving the CE aft. You may increase your mainsail area, reduce headsail area, rake the mast aft, or, if you have a centerboard, drop the board all the way down.

In many cases balance of a small boat can be corrected instantly by moving ballast—human or other—forward or aft. When ballast, acting on the CLR, is moved

RAKE OR STEP
MAST SLIGHTLY AFT



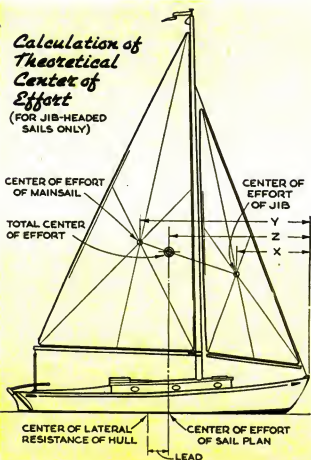
Correcting Excessive Lee Helm

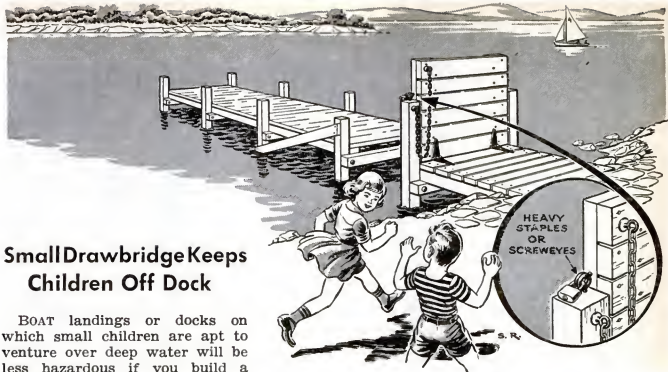
aft, the result is essentially the same as moving the CE forward; when it is moved forward, the CE is in effect moved aft.

Occasionally an entire centerboard will have to be moved or altered or a structural job may be necessary on the keel. But balance will have to be seriously off to demand such measures. Often enough for lee helm you need only to have a shipmate move a little forward, or to reduce weather helm have him move aft.

Calculation of Theoretical Center of Effort

(FOR JIB-HEADED SAILS ONLY)





Small Drawbridge Keeps Children Off Dock

BOAT landings or docks on which small children are apt to venture over deep water will be less hazardous if you build a drawbridge near the shore. Such a bridge can be made by hinging a 3' section of the floor on the shore side so that when it is raised and locked to a post, children are blocked from going beyond a point where the water is more than a foot or two deep. A rope or chain, attached as shown in the

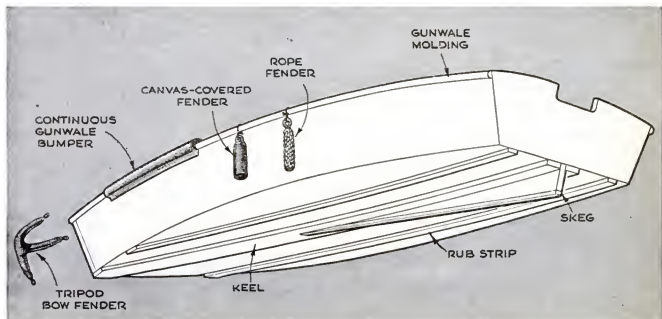
accompanying sketch, facilitates raising the bridge. Heavy staples or screweyes that come together when the bridge is upright form a place for a lock. Diagonal braces placed between the outer piles help keep the dock firm.—RALPH S. WILKES.

Protection Against Chafing Adds Years to Life of Small Boat

YOU MAY double, or even triple, the useful life of a small boat if precautions are regularly taken against chafing of the sides and bottom. Such wear causes serious damage, particularly when the boat is used constantly. Fenders that can be hung over the side are a virtual necessity if the boat is kept in a crowded anchorage or landed at a pier. These may be made of rope, or of canvas that is filled with cork, rubber, or kapok.

Another good chafing safeguard is a continuous bumper installed over the gunwale molding. A tripod bow fender is useful in some circumstances. Don't forget that discarded fire hose fastened around a pier or float will protect boats that land there.

If you must drag a boat up on a rough or rocky beach, it should have a keel or skeg and as many rub strips as are needed for protection.—WILLARD CRANDALL.



Pipe Smoker's Pipe Dream

IMAGINE making a choice from a collection of 347 pipes each time you wanted to smoke! At last count, E. T. Fredrich, of Seattle, Wash., could do just that. He began buying pipes 30 years ago while he was a tobacco salesman and has been at it ever since, picking them up in junk shops, at corner tobacco stores, or wherever he could find a type he did not have.

His collection, valued at \$4,000, includes specimens of the pipemaker's craft from Austria, Australia, Germany, Italy, England, and the United States. At right, Fredrich examines a fluted bowl.



Fine craftsmanship abounds in Mr. Fredrich's pipe collection. This bull's head is an Italian briar.

And here is the head of John Paul Jones, famous U.S. Navy commander, carved from French briar.



A delicate Swiss meerschaum turned out by a 19th century craftsman is highly prized by collectors.

This bowl is a man's head, and the hair, raised on a hinge, stands on edge while pipe is smoked.



Pins with scoring
feature add a twist
to an old favorite

By
MYRON FLEISHMAN



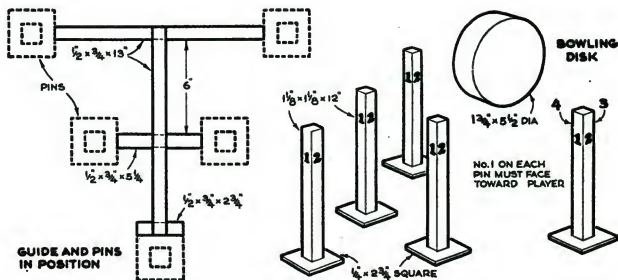
Disks Are Bowled in This Lawn Game

MANY of the thrills of bowling are combined with outdoor exercise in this game played with two bowling disks and a set of five square pins. Two or more contestants can take part, and the game itself is as suitable for the small city lawn as it is for that on suburban or country property. It can be played on a much smaller plot than that required for most outdoor games.

The disks are best turned in the lathe; but if a lathe is not available, it is still possible to saw them out by hand and round them with a rasp and sandpaper. This takes time, but with care a pair of disks can be shaped to roll straight and smoothly on a lawn or driveway. The pins are square stock, cut to length, sanded, fitted with

square bases, and numbered 1, 2, 3, and 4 on the four sides. A guide made to the dimensions shown is a help in setting up the pins quickly. Always set them up with the No. 1 sides facing the players.

Each player rolls from a preset mark 20' to 30' from the pins. He takes as his score the number showing on the upturned face of the pins he knocks over with his two disks, adding 10 points if he bowls them all over with his first shot or five if he knocks all down with two shots. No second shot is needed, of course, if he gets all the pins with his first. Ten such double tries for each contestant, with the play rotating, will make an interesting game. Total the ten scores to determine the winner.



STEEL...

KING OF SHOP METALS

Drill Rod or Cold-Rolled? High Carbon or Low? Here Are Facts to Help You Pick the Right Steel for Any Job

By WALTER E. BURTON

STEEL is the king of metals in most shops. If you know how to choose and to work the steel you want for a particular job, you will have licked one of the most persistent of the machinist's problems.

Fortunately it is not necessary to learn all about the dozens of varieties of steel in order to meet the demands of the practical shop; a very few types will suffice for nearly every need.

To understand the basic properties of the metal, we should glance quickly back to the humble ancestor of all steel—iron. Steel is produced from iron when carbon is added in such a way that it becomes part of the metal structure rather than an accretion of cinder or slag. The addition of carbon, however, is not the sole distinction. Cast iron contains around 3 percent to 5½ percent carbon in the form of uncombined graphite flakes, while in steel all of the carbon is normally combined with other elements, and the carbon seldom exceeds 2.2 percent.

Iron cannot be hardened, but steel can, and the amount of chemically combined carbon that is added determines how much hardness can be produced by proper heat treatment.

Wrought iron, such as makers of artistic lanterns and stair bannisters might use, is soft, malleable, and contains practically no carbon other than bits of slag. A wrought-iron bar has a fibrous structure somewhat like wood, and can be split parallel to the "grain."

The kind of true wrought iron that used to be so common is comparatively costly to produce from pig iron. Consequently the "wrought iron" you get hold of today may, in reality, be a form of busheled iron made by heating iron and soft steel scrap together and rolling or squeezing it to form bars or other shapes.

True cast iron is usually made by melting pig iron together with scrapped castings; it has a higher carbon content than steel and, although it is hard, it is not malleable at any

temperature. It is shaped by being heated to a liquid state and poured into a mold. Machining the hard shell of cast iron is particularly difficult, so it is usually a good idea to allow extra material in the pattern so that the first cut can be made deep enough to get under the scale. Further heat treatment will produce a kind of hybrid cast iron just as strong as the original but sufficiently malleable to be bent and twisted without breaking.

A very similar metal is a high-grade cast iron made by adding some scrap steel to the molten mass. The resultant material is known as semisteel and has greater mechanical strength than cast iron.

Ordinary steel is a malleable union of carbon and iron. Its hardness in the annealed state can be increased by heating it to redness and quenching it, by plunging it into water or oil. The greater the carbon percentage, the greater the strength of the steel and the harder it can be made. The carbon content of steel is expressed in "points," each point being equal to .01 percent. Thus, a steel with 0.15 percent carbon is said to have 15 points; 1 percent carbon is 100 points.

When carbon percentage is low, heating and quenching will not harden ordinary steel to a point where it is useful for such things as cutting tools. Low-carbon steel, therefore, is chiefly employed in making shafts, structural members and any one of thousands of other items in which hardness is not essential. But the same low-carbon steel containing, say, 15 points carbon, can be surface-hardened, or casehardened, by one of several treatments. Carburizing is the most common of these and consists of baking the steel in a loose compound of carbonized granules until some of the carbon molecules are transferred to the outer shell of the metal. Casehardened steel, having a hard surface over a soft but tough core, is well suited to the manufacture of dies, gears, engine parts and similar articles that must be resilient enough to resist breakage and yet be able to withstand much surface



abuse without wearing away or losing shape.

Casehardening is a handy procedure because it enables you to machine tools in a malleable and workable steel before hardening the shell of the finished product. A project of this sort is illustrated by the pictures at the top of page 174.

Steel with a carbon content ranging from about 55 to 70 points is known as medium carbon and is used for making such tools as hammers, garden implements, rivet sets and peens, chisels for masonry, setscrews, and dies.

High-carbon steels cover the span between 70 and 120 points; they are used to make files, wrenches, punches, vise jaws, lathe centers, cutting bits, and the like. The lower carbon steels in this group are preferable when considerable toughness plus some hardness are required; the higher carbons are employed when it is desirable to reverse the emphasis.

To obtain maximum hardness in cutting edges, steel having a carbon content of 120 points or more is used. This span is known as the very-high-carbon range, and steels of this order are made into tools for working such materials as brass, hard rubber, and wood. Reamers, files, and razor blades

are also commonly made from ultrahigh-carbon steel.

For the average shop, carbon-steel drill rod is a basic material. From it you can make all sorts of useful tools—punches, dies, chisels, and other things requiring considerable hardness and reasonable toughness. Drill rod usually ranges around 120 points carbon and is available in handy lengths ground to extremely accurate diameters.

Heat treatment of carbon steel is not difficult. In most shops the chief drawback is the lack of adequate temperature-measuring facilities, but this can be partially overcome by working from color indications. The table given at the top of page 175 shows the surface colors that carbon steel will assume at various tempering levels. In using such a table it is important to make due allowances for specific differences due to variations in carbon content, light, visual reactions, and so on. There is considerable leeway for experimentation, however, since most steels can be tempered repeatedly. After a few trials you will become familiar with your own scale of color values.

If you want to work a piece of steel that has already been hardened, you must first

anneal or soften it. This can be accomplished by heating the steel to cherry redness and allowing it to cool slowly. It can either be left to cool with the furnace, or it can be buried in lime or fine sand so that the heat will escape slowly.

Forging is a common way of shaping knife blades and other tools. Heat the steel to bright redness; then hammer it to shape, reheating every time the steel loses its redness. Hammer the steel so that it is compacted uniformly in all directions. In forming a knife blade, for example, pound it along the edges as well as along the flat sides.

For hardening and tempering small tools you can use a torch flame directed into a pocket formed by pieces of fire brick or asbestos, such as is illustrated on page 173. A gas flame fed by a forced-air draft may also be used. For extensive forging or hardening operations, you may want to construct a small gas or electric furnace.

When steel is heated by an open flame or in an ordinary gas-fired furnace where the flame comes in contact with the metal, the carbon near the surface may burn out, causing decarburization and loss of hardness. The surface may also acquire a scale which is difficult to remove.

Special "atmosphere" furnaces that prevent oxidation are used in industry. Some manufacturers of steel suggest that pieces to be hardened be dipped in a saturated solution of boric acid before heating. By immersing the work in some material that keeps oxygen from striking it during heating to a high temperature, decarburization and scale are eliminated. Often the pieces emerge from quenching almost as bright as before they were heated. Molten lead and neutral salt baths are commonly used; the latter are available in mixtures that melt at various temperatures.

An additional advantage of such baths is that they heat uniformly. This is particularly important in working slender or irregularly shaped tools. Without the temperature-regulating solution, the sharp end of tools such as punches sometimes becomes



Disk-Cutting Tool Project Illustrates Method of Heat-Treating Carbon Steel

POCKET tools, such as those illustrated above and laid out in the diagram at the lower right, are useful in most shops. The tool for cutting disks of cardboard, fiber, or soft metals is hardened tool steel; the key-ring scriber punches can be machined from cold-rolled steel and casehardened by the steps shown on page 174.

Before steel can be hardened, it must be heated above its critical temperature. Fig. 2 shows a torch being applied to the steel in an improvised brick furnace. There are three ways of determining when the proper temperature has been reached. If a pyrometer is used, heat 70-point carbon steel to 1,450 deg. F; 80-point carbon reaches its critical temperature at 1,440 deg.; steel with more than 80 points carbon needs 1,440 to 1,425 deg. Manufacturers' recommendations should be followed when available.

The second method for determining the critical point is to heat the steel until its color turns a luminous cherry red.

A pocket magnet can be used for the third test. As long as temperature is below the critical point, steel responds to a magnet; above this point there is no attraction.

Usually steel is heated to a few degrees above the critical point to allow for some cooling as it is being moved to the quenching bath. Figure 3 shows the

brittle before the body is properly tempered; with it a uniform structure is obtained throughout.

Although most oxide colors disappear when carbon steel is allowed to cool, blue forms a permanent color coat on the metal. Occasionally this treatment will be found handy around the shop as, for example, when blued screws are needed. It is almost as easy to blue them as to buy the com-

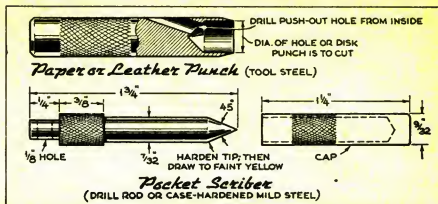


rod being plunged into the liquid to harden the steel.

Is it hard? The file test (Fig. 4) gives the answer. If the teeth of the file refuse to bite into the metal, it has responded properly to hardening treatment.

Before tempering, polish an area of the hardened steel with abrasive cloth (Fig. 5) so that the tempering colors will show. Apply a torch evenly over the surface of the steel, and the instant the proper tempering color appears—or even a moment or two before—remove the torch. The steel may be allowed to cool in the air or it may be quenched in oil. The former method is preferred by many shop men on the theory that it produces fewer stresses in the metal.

In tempering, special allowances must be made for any unequal thickness of the tool.



mercially blued product. An electric furnace is probably the neatest heating device, but the careful application of torch or gas flames will also do the job. Aside from producing an attractive finish, a blued surface is less likely to rust than one that is simply left unfinished or polished.

While regular quenching oils can be purchased, a satisfactory substitute can be made by mixing linseed oil with about half

its volume of automobile engine oil. The latter can be used alone, but has a tendency to flame and burn which makes it somewhat dangerous for indoor use.

The best way to determine whether a particular piece of steel will harden sufficiently for the purpose you have in mind is to saw off a small amount and put it through the hardening process. Then test it with a file. If the file won't bite into the metal, it is



CASEHARDENING of tools is especially useful when it is necessary to machine the metal with extreme accuracy. Fig. 6 shows the scriber-punch nearly ready for the pack-hardening operations.

An old can is used here as a container for the steel parts which are buried together with a carburizing compound. Fig. 7 shows a commercial compound, but you might want to try charred leather or bones such as the ancient armorers used. Wood charcoal

or charred sugar or horn can also be used.

Place the packed tools in a furnace (Fig. 8) and heat them, together with the carburizing material, to about 1,700 deg. F., for approximately 3½ hours. Thickness of the hardened case depends upon the temperature and the length of time the work is heated. After the steel has baked, sift it out of the compound and let it cool. Reheat to about 1,450 deg. F. and quench in water. Temper to a dark straw color.

probably hardened enough for most purposes.

Alloy steels should be hardened and tempered in accordance with instructions furnished by the makers. The average shop owner will be interested in using such steels rather than heat-treating or otherwise processing them. Of particular interest are high-speed steels used for lathe bits, drills, reamers, and so on; the life and service of such metals depend largely upon what the mechanic does to them.

High-speed alloys are those containing such elements as tungsten, chromium, and vanadium, which impart several valuable properties, including the ability to retain a cutting edge at temperatures that would destroy the hardness of ordinary carbon steels.

Even though a high-speed steel tool may hold its edge when red hot, it should be ground carefully so as to avoid heating it beyond the point where you can hold it in your fingers. During the grinding it should never be cooled by being plunged into water. A water-lubricated wheel is helpful; the old-fashioned grindstone, used wet, will ruin fewer high-speed tools than a modern grinder used the way most mechanics do. After grinding, use a hand hone to produce a keen edge, and you will get noticeably longer life between grindings. High-speed steel does not hold as keen an edge as does high-carbon steel, and is therefore not as good for working wood or doing other jobs where keenness is the prime requisite.

Stainless steel is an alloy made up chiefly of iron, chromium, carbon, and sometimes nickel. There are various kinds of stainless steel with differing properties. Some will and some won't harden under heat treat-

ment; most of them can be hardened by cold working, but some types respond to this treatment more readily than others. In general, manufacturers' directions should be followed whenever possible in hardening or annealing stainless steel.

Chromium is the element that gives stainless steel its ability to resist corrosion. To insure the highest degree of corrosion resistance, the surface of the metal should be highly polished.

Proper and exact identification of steel is almost impossible outside the laboratory, but the rough-and-ready methods of the machine shop can afford quick and reasonably accurate answers to many questions. One of the handiest methods is the spark test, in which a piece of the steel in question is held against the grinding wheel and the color, volume, and shape of the resulting sparks is noted. In general, high-carbon tool steel produces a generous shower of many-branched white sparks. Low-carbon or mild steel produces light yellow sparks but not in as great abundance and not as branched. High-speed steels produce relatively few sparks; such as they are, they are usually deep yellow with a tendency toward red, and they show few if any branches. By comparing the sparking ability of known samples, you can easily work out your own system. The table at the bottom of page 175 illustrates some of the more recognizable varieties of sparks.

A small pocket magnet is handy for distinguishing high-speed steel from alloys composed of such materials as tungsten carbide. The magnet will attract the former but not the latter.

CARBON-STEEL OXIDE COLORS FOR TEMPERING

COLOR	Deg. Fahr.	
Pale blue	—650	{ chisels, springs, percussion tools; articles to be given blued finish.
Bright blue	—600	
Dark blue	—550	{ cold chisels and other percussion tools, gimlets, wood chisels, wood-planer knives, and molding cutters to be filed, wood saws, bits and augers, springs.
Purple	—540	
Bronze purple	—530	
Bronze (brown)	—500	{ stamps, punches, engraving tools, twist drills.
Deep straw (golden yellow)	—475	{ lathe, planer, and shaper bits; gauges, hammers, wood chisels, taps and dies, rock drills, punches and dies, reamers, planer knives and molding cutters to be ground, gouges, plane irons.
Straw (yellow)	—450	
Faint straw	—400	{ tool bits and scrapers for brass, hammer faces, planer tools for steel and iron, milling cutters.

QUALITY in tools depends equally upon the materials that are used and the skill with which they are made. Especially in the tempering process is craftsmanship important, for in heating and quenching hardened metal in order to make it less brittle, you also soften the steel. It is therefore necessary to strike just the right balance for the use you have in mind. As steel is heated, a thin oxidation

film forms on its surface and changes color as the temperature changes. Since color variation is very constant, it can be used as a guide when heating metal. Very few standard tables agree as to exact color-temperature ranges, and the one given here represents an average of some of the more common ones. Before using color in a critical operation, try it out on tools which allow some leeway.

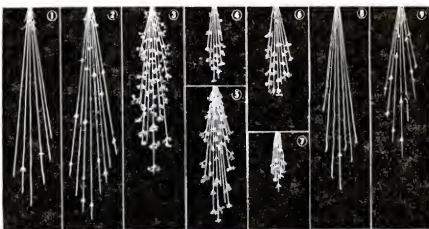
Stainless steel, for all its virtues, is usually a sore thumb when it comes to shop testing. It is hard to identify without making a chemical test; some types are magnetic, some are not; grinding wheel patterns vary, too.

Part of this difficulty comes from the fact that the term "stainless" is rather loosely

applied. Many of the so called stainless or rustless steels can be attacked by corrosive agents. Truly stainless steels can usually be distinguished by applying a drop of vinegar to a polished surface. Allow the vinegar to dry and rinse the metal with hot water. If no stain is left, the steel can be considered reasonably stainless.

Grinding Sparks Furnish Key to Classification of Metals

SPARK testing offers one of the most practicable shop methods for distinguishing and classifying metals. Irons, steels, and many nonferrous metals give forth distinctive sparks when held against a grinding wheel. By studying them, it is often possible to identify an unknown sample or compare the properties of different pieces.

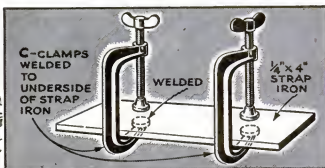


Metal	Volume of Stream	Color Close to Wheel	Color Near End of Stream	Quantity of Spurts	Nature of Spurts
1. Wrought iron	Large	Straw	White	Very few	Forked
2. Machine steel	Large	White	White	Few	Forked
3. Carbon-tool steel	Moderately large	White	White	Very many	Fine, repeating
4. Gray cast iron	Small	Red	Straw	Many	Fine, repeating
5. Manganese steel	Moderately large	White	White	Many	Fine, repeating
6. Annealed mall. iron	Moderate	Red	Straw	Many	Fine, repeating
7. White cast iron	Very small	Red	Straw	Few	Fine, repeating
8. High-speed steel	Small	Red	Straw	Extremely few	Forked
9. Stainless steel	Moderate	Straw	White	Moderate	Forked

Courtesy H. W. Wagner, Norton Company Research Engineer

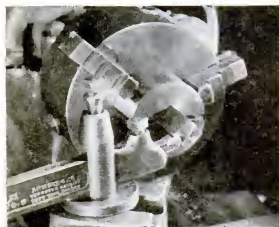


WHEN BUTT JOINTS are being welded or brazed, this tool will hold the two pieces of metal firmly together until they have been joined. It was made by welding a piece of strap iron to the immovable jaws of two C-clamps. If you make two, one can be clamped across each end.—**JOHN KRILL.**



IF SHARPENED to three points with a center and two side cutters, a standard twist drill makes a perfect tool for drilling holes through light metal. Used with a hand brace, a 1" drill will cut through 22-gauge metal, making a perfectly round 1" hole. If several such drills of various sizes are sharpened, you should find them a useful addition to your tools.—**CHRISTIAN LEONARD.**

EXACT MEASUREMENTS of the wall thickness and inside diameter of tubing can be obtained with an ordinary micrometer if a piece of $\frac{1}{4}$ " drill rod is used as shown here. From the micrometer reading, deduct the $\frac{1}{4}$ " rod diameter, and you will have the wall thickness. Subtract double this figure from the outside diameter for the inside diameter.

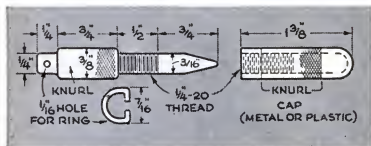


IN TURNING SQUARE STOCK you need not spend a lot of time adjusting each new piece if you fit a three-jaw chuck with an adapter such as that shown at left, for all square pieces will center automatically. This affords an enormous timesaving over the use of an independent four-jaw chuck on repeat work, and the adapter compensates for slight differences in stock sizes.

Use cold-rolled steel for the adapter, turning it to a diameter of about 2" or whatever will suit the minimum size of the square stock you expect to use. After sawing the piece in half, cut an accurate V-notch of 90 deg. in each half on a milling machine or a shaper.—**C. W. WOODSON.**



Machined to the desired shape from a scrap piece of drill rod, a pocket magnet is put to use above to determine whether the screws are all brass or are merely plated. At right, how it is magnetized.



A POCKET MAGNET with a hundred uses can be made by machining a piece of $\frac{3}{8}$ " drill rod, the shank of a discarded twist drill, or an annealed round file to the shape shown in the drawing above.

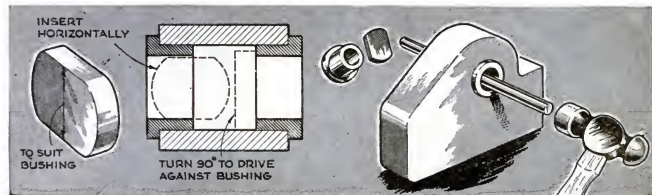
Thread one portion to accommodate a metal or plastic cap for keeping unwanted bits of metal from the magnet. If you chuck a piece of $\frac{1}{8}$ " brass pipe—the kind used in electrical fixtures—and spin one end shut, then thread the other internally to match the threads on the magnet, you will

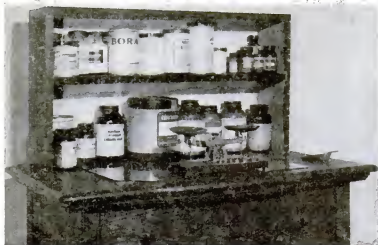
have an excellent cap. Although the brass ring is optional, it will be found convenient if the magnet is to be carried in a key case or on a holder.

After you have finished the magnet to shape, heat it to a cherry red and quench it in water to give it hardness. Then magnetize it by stroking it on a larger magnet or inserting it in a solenoid coil. You can use the field coil of an old 6-volt radio loud-speaker with the core removed (see P.S.M., October, '43).—W. E. B.

REMOVING BUSHINGS or brass bearings from both ends of a barrel retainer often is a problem because of the difficulty of applying the necessary force to the first one. But that difficulty can be overcome by cutting a small piece of steel plate to the shape shown

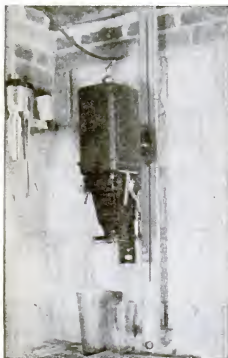
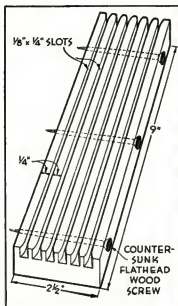
below. Once this piece is inside the retainer and turned sideways, it is an easy operation to knock out the bushing or bearing by inserting a steel rod into the end of the barrel and striking the rod with a hammer.—J. H.





BY ATTACHING SHELVES to an old dresser you will have a spot for compounding photographic developers, hypo, and other solutions at a comfortable working level with a minimum of lost motion. You can use the dresser top itself as the base for your scale, and chemicals kept on the shelves are within easy reach. A sheet of window glass under the scale will give you a working surface that can be easily wiped clean of chemical dust. The drawers of the dresser provide storage for photographic equipment.—GEORGE S. FROST.

FERROTYPE TINS stored in this rack are always handy although neatly out of the way. Cut slots about $\frac{1}{8}$ " wide, $\frac{1}{4}$ " deep, and $\frac{1}{4}$ " apart in each of two strips of $\frac{3}{4}$ " stock. The width of the strips can vary according to the number of tins you wish to store. Flare the outer ends of each groove so the tins will go in easily. Drill holes for screws through both of the strips, and attach one, facing up, to the side of a cabinet or other suitable place. Then use several tins as guides to find the proper place for the upper strip, allowing about $\frac{1}{8}$ " more than the length of the tins.—WILL THOMAS.



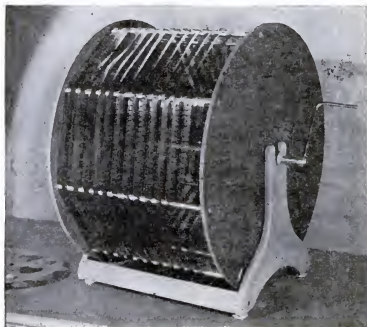
HORIZONTAL en-largers, including those which clamp to the back of a camera, can readily be modified for vertical use. Remove the housing base, leaving only the connecting arm and wing nut and bolt. Make a new slide by cutting a $\frac{3}{8}$ " slot through-out most of the length of a board about 5' long, $2\frac{3}{8}$ " wide, and $\frac{3}{4}$ " thick. If desired, this can be built up from two $\frac{3}{4}$ " by 1" by 5' pieces, held apart at the ends by $\frac{3}{8}$ " spacers. Bolt the slide to the wall, leaving about 3" for clearance.—ARTHUR L. SCHOENI.



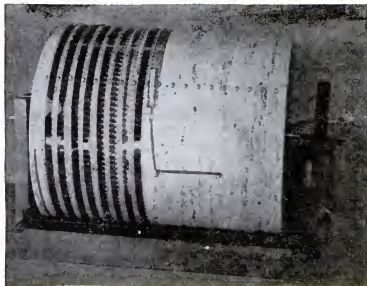


Homemade processing and drying reels eliminate delay. They let you view your home movies within 24 hours.

By ERVIN WALTERS



This is the equipment needed. The drying reel is shown above and the linoleum-covered developing drum below. A tilted tray under the drum carries processing solutions.



WHY postpone that thrill that comes with seeing for the first time what you have taken with your movie camera? There is no need to if you provide yourself with an elementary darkroom, a safe lamp, a set of inexpensive trays, chemicals recommended by the film manufacturer, a developing drum, and a drying reel. Aided by this equipment, you can entertain at home-movie shows with film taken the day before.

Any small room that can be shut off completely from light is suitable for a darkroom. A bathroom or kitchen that meets this requirement is ideal, for running water is a convenience though not a necessity. The safe lamp, developing trays, and chemicals can be purchased at any camera-supply shop. You yourself can make the developing drum and the drying reel.

The former is a linoleum-covered frame with plywood ends; the latter, two plywood disks connected by non-corroding metal tubes or hardwood dowels. With them you will be prepared for developing, reversing, clearing, and fixing, instructions for which may be obtained from film manufacturer's literature.

If you have a 16-mm. camera, you will want your drum and reel about 17" in diameter and 22" in length to take 110' of film. Or you can reduce the diameter to 13" and the length to 15" for 55'. If you use 8-mm. film, a diameter of 11" and a length of 12" will be sufficient for 55'.

Cut two end disks for the developing drum from plywood, pressed composition paneling, or similar material, and cut eight uniform strips for the ribs from $\frac{3}{4}$ " or 1" wood stock. Bore the end disks in the exact center for a shaft; then attach them to the ends of the ribs with countersunk flathead screws. Space the ribs equally and with their outside faces flush with the rim of the end disks so they can be planed to a rounded surface that will

permit smooth laying of the linoleum covering.

A noncorroding-metal pipe or tube $\frac{3}{8}$ " in outside diameter or a hardwood dowel serves for a shaft. Have it 3" or 4" longer than the drum so its ends will project and engage notched uprights on the stand. Make a plate that can be soldered or glued to the shaft and screwed to one end disk. Two spacing collars will keep the shaft from shifting endwise. One should be soldered or glued to the shaft and the other fitted with a setscrew. Turning of the drum will be facilitated by a knob or crank at one end of the shaft. A large radio knob is shown on the developing drum illustrated, while a crank made of a bent rod threaded and screwed into an additional collar is shown on the drying reel.

Light-colored waterproof linoleum is best for the covering. Cut it $\frac{1}{2}$ " wider than the length of the drum and long enough to overlap slightly so it can be trimmed with a sharp knife to a perfect, close-fitting butt joint. Center the joint on one of the ribs, and fasten the linoleum both to the ribs and the edge of the end disks with waterproof linoleum paste, resin glue, or some other good adhesive. Small nails or brads will hold the linoleum at the seams while the adhesive sets. When it has dried, trim the projecting edges flush with the surface of the end disks and smooth them with a file and fine sandpaper. If there are cracks at any joints, fill them with plastic composition wood. Sand this smooth and file down any projecting nail heads.

Spacers will be needed to hold the turns of film in place. Those shown are staples bent from 1/32" stainless-steel wire and driven into drilled holes in the linoleum on every other rib. They protrude about $\frac{1}{8}$ ". Brass or other noncorroding wire may be used, and any diameter up to 1/16" may be bent readily, or wood, plastic, or metal pins will serve. Be sure to round the exposed ends of metal pins to avoid scratching the film. For 16-mm. film, place the spacers on $\frac{3}{4}$ " centers, and for 8-mm. film, on 7/16" to $\frac{1}{2}$ " centers.

Fasteners for the ends of the films are two double-claw hooks bent from nonrusting wire. These are shaped so the prongs can be inserted in sprocket holes at the two ends of the film. Screw an L-shaped hook in near the left-hand side of the drum so that a strong rubber band or two or a flexible coil spring looped into one of the double-claw hooks can be held on it. Then, for a similar fastening at the other end of the



Ribs in the developing drum frame are put on flush with the ends, and the outer faces are planed round.

When film is drained, the shaft is lifted from the upright and rested at an angle in the notched block.



film, screw in several L-shaped hooks at different points near the right-hand side. Put them into ribs not occupied by spacers. They are needed at several points because the length of film processed will not always be the same.

The second double-claw hook is also equipped with a rubber or spring connecting link; and thus, when a strip of film is loaded on the drum with the flexible links pulled to about twice their normal length, slack will be taken up when the film becomes wet and stretches. Be sure to place the end attachment hooks in the drum so they will be between turns of film. And, in processing, remember to wind the film on the drum with the emulsion side out.

Before using the drum, wash the linoleum with lacquer thinner or a similar solvent to remove grease and wax, and then coat the linoleum, ends, and metal parts with lacquer, synthetic enamel, or another waterproofer that will also resist chemicals.

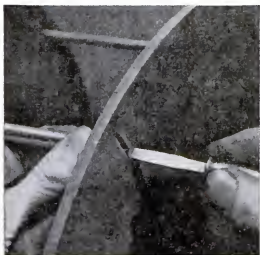
The drying reel is similar to the drum with the exception that it is not covered



Linoleum is fastened to the drum with waterproof adhesive and held with brads, as at left. Noncorroding metal staples are driven in for spacers so the film won't overlap. They are put in on every other rib.



One rib of the drying reel, shown below, is made adjustable by being held by a bolt in a slot. Double claws, attached to rubber or a spring, engage sprocket holes at the film ends. A handle aids turning.



with linoleum. Scribe the end disks with a circle $\frac{5}{8}$ " to $\frac{3}{4}$ " inside the outside circumference, and then bore the centers for the shaft. Noncorroding metal rods are best for the ribs, but hardwood dowels can also be used. Provide eight ribs, equally spaced as on the drums, and drill holes for them in the scribed circle. If $\frac{1}{8}$ " brass or similar metal tubing is available for ribs, it may be attached by plugging the ends with 6-32 brass nuts turned down to a tight fit. Short flathead 6-32 bolts inserted through holes in the end disks will engage the nuts.

Double-claw fasteners similar to those used on the developing drum hold the film on the drying reel. Connect them with rubber bands or light springs to single hooks that can be slipped over any convenient ribs.

Since wet film stretches and drying film shrinks proportionately, the elastic mountings will take care of most of the play. You should, however, make one rib adjustable by fitting its ends in 1" slots instead of holes, as indicated in one of the photos above. Then, as the film dries and shrinks,

the bolts engaging the ends of this rib can be loosened and the rib moved in slightly. Spacers are not as necessary on the drying reel as they are on the drum, but if desired, metal, plastic, or wood pins may be inserted in holes drilled in the ribs.

Stands for both the drum and drying reel consist principally of two uprights notched at the top to take the shaft ends and attached to a suitable base. As indicated in the lower photo on the facing page, a notched block is attached to one of the uprights so the film can be drained between processing steps simply by lifting that end of the shaft and inserting it in the notched block.

The base of the developing-drum stand is a rectangle slightly longer than the trays used but not as wide. An inserted tray will thus be held on a tilt. Position the uprights slightly off-center so the tilt of the tray will be forward and the bottom of the drum will be immersed at the deepest point. Turn the drum when using it so the film will be carried toward the shallower side.

CAN YOU BEAT THESE PICTURES?

We will pay \$5 for any photo used on this page. Write your name and address on each print. Enclose a stamped, self-addressed envelope and the negative, if it is available, and send your contribution to the Curious Photos Editor.

JUST A CUPFUL OF DOG is what Don Aufderheide, of Indianapolis, calls the photo at the right. The little animal, posing contentedly enough, is undoubtedly a great deal more bark than bite—and it may even be more bark than dog if our eyes don't deceive us.



WITH WARTIME ROCKETS in the limelight, the "rocket to the moon" shown at the left is particularly appropriate. Robert Scott, of Saltsburg, Pa., made this fanciful photograph. It is a plastic flashlight on a piece of glass laid over some wads of cotton. A paper negative was made to enable the exhaust jet at the back and the lighted portholes to be added in pencil. It makes just the craft for an interplanetary vacation jaunt.



EASTER EGGS? No, just those of a hen with an odd interest in photography. Jennings Hopkins, of Paragould, Ark., explains the picture with the theory that the eggs were photosensitive for a short time after being laid. When the hen had deposited these in the nest, bright sunlight shining through a wire-screened part of the chicken coop did the rest.



SKYSCRAPER IN THE STREET. How does this one differ from the buildings you've seen—and perhaps photographed—in puddles following a rain? It's a trick question. This is how such a reflection would look if you stood on your head; we've turned the picture over.

BOOM LIGHT GIVES FLEXIBLE PHOTO LIGHTING

ONE of the most valuable pieces of equipment a photographer can make for himself is a boom light on wheels with a long counterbalanced boom. With such a light, illumination can be directed exactly where needed for any particular setup.

The base should weigh between 30 and 50 lb. A junk yard may yield a cast-iron base of proper shape and weight—or at least a wheel or heavy object convertible to such use. You might also improvise a base from a box filled with sand, bricks, or gravel. Mount the base on swivel casters so that the light will roll easily in any direction. If the base is iron, a wooden platform will facilitate attaching the casters.

A good length for the vertical member, which is of 2" by 2" stock, is 40". To determine the length of the boom, measure the

distance from the top of the vertical member to the ceiling and add about 26". Of this length, 16" should be devoted to the counterweight end. Keep the long arm as light as possible. A sturdy metal curtain rod fitted securely into a piece of hardwood makes a good boom. An inch or two of thin-wall pipe forced over the wooden end will keep it from splitting. The clip-on type of photographic lamp, being equipped with a ball and socket joint, is excellent for the light itself.

The boom pivots on a short piece of metal rod passed through it and the vertical member. Center two wooden disks 4" in diameter on the rod and notch each into the facing surfaces of the vertical member and boom. Fasten a doorknob on one end of the metal rod with a setscrew. On the other end thread a nut. When the knob is turned, pressure on the disks locks the boom.

For convenience in using the light, the counterweight should be as flat as possible and just heavy enough to balance the boom. To determine the weight required, suspend a bucket on the counterweight end, after the light is otherwise complete, and pour in weighting material such as sand or gravel until the boom balances. Weigh the bucket and material and divide this figure by the weight of one cubic inch of the weighting material. The result will be the cubic capacity of a wooden box just large enough to hold the amount needed. Make a box of this size, bolt it on, and fill with material.—CHARLES AND BERTRAM BROWNOLD.



The counterpoise allows the light to be positioned at any level from ceiling to floor.

In use below, the light is wheeled into place on its swivel casters and adjusted to illuminate photo subject on table.

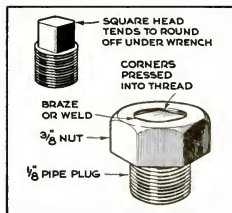
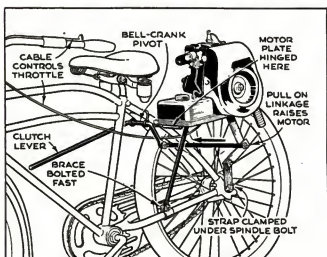
Friction disks, locked in place by a doorknob as handle, hold the boom in any angle that you may select.





Bikes Powered by Old Engines

SMALL $\frac{5}{8}$ -hp. gasoline engines taken from old washing machines drive the bicycles of paper-delivery boys in Grants Pass, Ore. Each motor is mounted on a floating platform over the rear wheel, which it drives by means of a friction spool resting on the tire. Interchangeable spools of two sizes are used—a small one for power in hilly country and a large one for speed on level roads. An old motorcycle control governs engine speed. The boys average about 25 m.p.h. on level stretches and travel more than 100 miles on a gallon of gasoline. A bell-crank lever acts as the clutch.—DALE VINCENT.

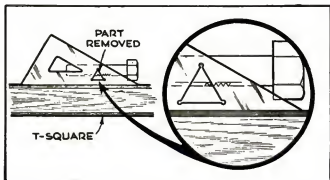


Nut on Pipe Plug Makes Removal Easy

REMOVAL of small pipe plugs becomes a problem if their heads round off, leaving no surface that a wrench will grasp. This difficulty can be prevented by forcing an SAE nut over the head. Squeeze the two together in a vise to do this. If a nut of the right size is selected, the corners of the plug head will be forced across the threads. For instance, a $\frac{3}{8}$ " SAE nut will fit over the head of a $\frac{1}{8}$ " pipe plug and a $\frac{1}{2}$ " nut over a $\frac{1}{4}$ " plug. The hexagon head of the nut forms an ideal surface for a wrench and is less likely to round off. Brazing or welding will hold the nut on the plug.—C. H. HARDY.

Triangle Aids Thread Drawing

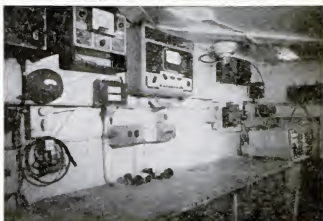
AN EQUILATERAL triangle cut in an ordinary draftsman's triangle will provide a handy guide for drawing thread profiles, making it unnecessary to keep turning the instrument itself. In cutting the opening, make certain that one side is parallel with the edge of the triangle so that when the latter slides along a T-square the thread lines will be at the same angle.—H. D.



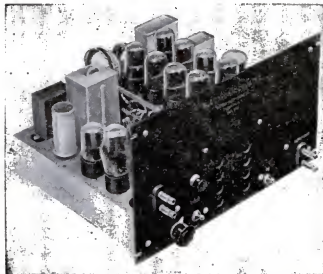
radio ideas

RADIO REPAIRS at advanced bases of one 9th Air Force squadron did not have to wait for standard equipment to be brought up from the rear. T/Sgt. Forrest D. McDaniel, of Wichita, Kan., an assistant communications chief of a Marauder group, built this mobile repair unit that could be carried anywhere by truck. Made of scrap lumber and large packing crates, the shack was fully equipped with regulation aircraft radio instruments for quick tests and repairs.

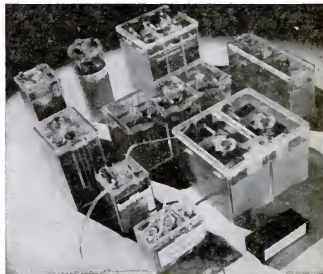
Two gas-engine power plants supplied the electricity required for operation of the shack. The lower picture shows how the test equipment rigged above the bench conserve the limited amount of space available for work or storage. Flattened tin-can sections were used to waterproof the roof, and the joints of the cabin were securely reinforced to withstand the strains of moving.



AN ELECTRONIC COUNTER, capable of being adapted to a variety of counting operations, has been announced by the Potter Instrument Co., of Flushing, New York. The device may be actuated by a mechanical contact, an A.C. pulse, or an electric input as from a photocell. Because it works electronically, the machine is said to withstand high speeds and continuous operation better than most conventional counters.



PLASTIC BATTERY CASES made of polystyrene have been produced by the Willard Storage Battery Co. The trim appearance of these power units is obtained without sacrificing efficiency, for polystyrene is a transparent plastic with high resistance to the action of acids and other chemicals. By permitting the interior of the battery to be seen, it provides an almost automatic check on the liquid level.



TRANSMITTING TUBES must be protected against circuit losses at every contact point, especially when used at high frequencies. To provide this protection, the E. F. Johnson Co., of Waseca, Minn., designed the socket shown at the left to accommodate the new jumbo four-prong tubes. It is molded from a single piece of steatite.

ELECTRONICS WITHOUT

Vacuum Tubes Can't Handle the Infinitely Small Wavelengths of the

By JOHN W. CAMPBELL, JR.

ELECTRONICS is sometimes called the science of vacuum tubes. It isn't.

But when you consider the prodigious feats that have been performed by ingenious arrangements of cathodes, grids, and anodes, it is not to be wondered at that many people look upon vacuum tubes and electronics as practically the same thing, or, at any rate, inseparable.

As a matter of fact, electronic science has now reached a point where it has driven vacuum tubes into a corner. These little metal or glass gadgets are still doing a wonderful job down in the basement of the

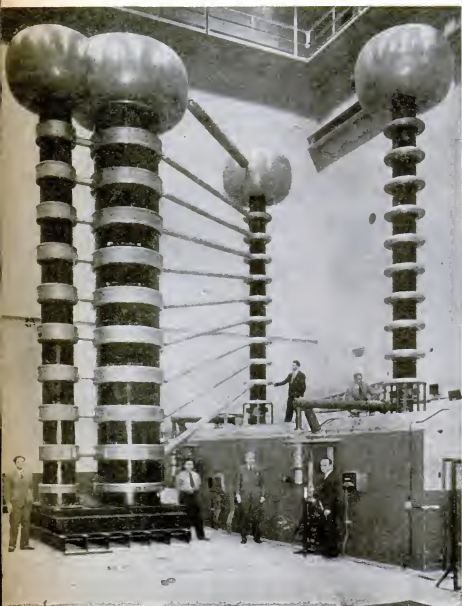
radio spectrum, but when they try to climb out they find that nature has a tendency to push them back.

The scale of wavelength distribution on the opposite page shows the portion of the spectrum that vacuum tubes can cover. It looks pretty big until you notice that the scale is drawn logarithmically—that is, the distance between 10 and 100 looks the same as that between 10 trillion and 100 trillion. If the divisions had progressed by spaces arithmetically equal to those at the bottom, ten full years' printing of this magazine would not have furnished enough paper to draw a single scale!

Waves in different regions of this vast spectrum naturally exhibit different characteristics, and as the characteristics change, so must the devices and materials that are used to study or control them. In the higher frequencies and correspondingly shorter wavelengths, vacuum tubes have run into a seemingly insurmountable obstacle—size.

The highest frequencies that have yet been reached in radio communication employ almost microscopic tubes—tubes so small as to make even the tiny acorn tubes seem gross by comparison. Tubes have to be small because the resonant-circuit frequency depends upon the inductance and capacitance of the circuit (indicated symbolically by the letters L and C respectively). At ordinary frequencies the L and C factors are governed by an external arrangement of wire coils and condenser plates in the tuning circuit. At 1,000 megacycles (1,000 mc.) these values must be extremely low—so low, in fact, that the internal cathode-to-plate capacitance of ordinary tubes and the inductance of the shortest possible leads from grid to cathode exceed the total permissible value of L and C.

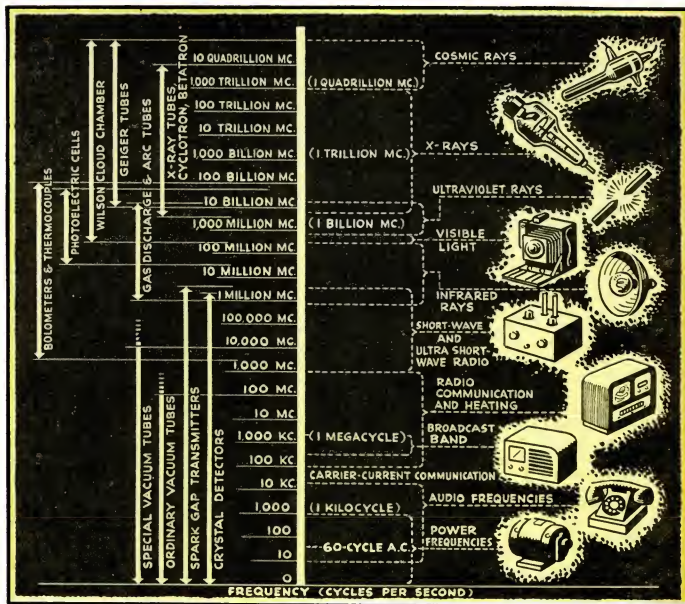
X-RAYS vary in penetrating power according to the force with which electrons are emitted. This machine gives electrons a 1,400,000-volt send-off.



Courtesy General Electric

VACUUM TUBES . . .

Ultrafrequencies, But Atomic Structures Work Anywhere in the Spectrum



To operate at still higher frequencies, say 1,000,000 mc., tube components actually would have to be microscopic!

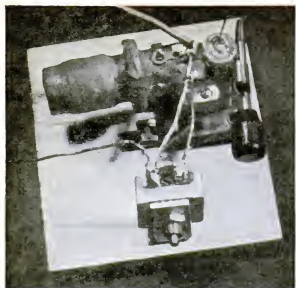
Nor is this the only way in which size hampers vacuum tubes. In a vacuum tube, the flow of electrons takes place from a negative cathode to a positive anode or plate. By our ordinary human conceptions of time, these electrons travel at enormous speeds. Electronically, however, they are not fast enough.

Let us assume that we are dealing with a large vacuum tube. Electrons leap out of the cathode and travel across to the plate in, say, one millionth of a second. What do you do when you want to use frequencies above one megacycle—that is, when the flow must alternate faster than a million

times a second? Obviously you make the distance smaller—much smaller. But even when you get electrons alternating ten or a hundred million times a second, you still haven't scratched the surface of the available frequencies. No matter how hard you try, you just can't make already tiny tubes a thousand times smaller still!

But while size may be a crusher to a vacuum tube, it is no problem at all to an atom. Atoms have no internal capacitances or inductances, and their internal distances are so minute that the question of transit time need hardly be raised. This is almost equally true with respect to spaces between atoms in a molecule.

If only we could get atoms to do our electronic work directly . . . [Turn the page.]



CRYSTALS play a large part in both the sending and receiving ends of radio. Typical of many old-time sets is the galena detector model, left, which can operate entirely without tubes. A piezoelectric quartz crystal in the oblong holder (arrow) controls the carrier frequency of the transmitter shown at right.

As a matter of fact, they have been doing it since before radio was born. Hertz didn't have vacuum tubes and neither did Marconi. They worked directly with atoms, and now we're going back to follow their lead. Back to the neglected stepchildren of electronics: the oscillators and frequency-responsive materials that played such a large part in the early days of radio.

For example, spark-gap transmitters of the type used by Hertz in the experiments that led to the discovery of radio have not been surpassed in frequency range by any vacuum-tube device yet built! One of our upper high-frequency transmitters uses a tricky spark-gap device that consists of particles of metal dust suspended in an oil bath. When the bath is put between the terminals of a high-voltage supply, tiny sparks occur between the minute metal particles, converting each particle into a resonant circuit. Electrons race across the surface of the particle to the point at which the arc takes off, constituting a current. The capacitance between the particles, acting with the inductance effects of the flowing currents, constitutes a circuit tuned to an enormously high frequency.

To use these frequencies in communication, it is necessary to be able to detect the signals generated. This can be done in several ways. Crystal detectors operated in conjunction with local oscillators, such as are used in superheterodyne radios, can knock a very high frequency down into a lower, more manageable frequency range.

Right up along with spark gaps in the class of renovated old-timers is the crystal detector. If you recall the dim days of radio pioneering, you undoubtedly remember the humble chip of galena that was used to de-

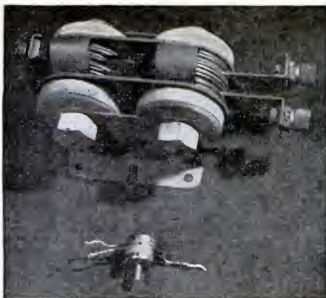
tect and demodulate the broadcast wave. That crystal, too, has never been surpassed or even equaled! Having no cathode-to-plate capacitance, a tightly mounted crystal works well up to 1,000,000 mc.

Crystal detectors, to be sure, do not afford us any amplification and cannot handle strong signals, but in putting atoms to work directly they exemplify an important type of action known as "barrier-layer phenomena."

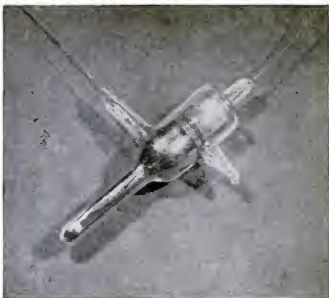
In effect, a barrier layer is a layer of molecules showing a definite orientation with respect to electron movements. We can detect its formation by the fact that electrons can move through it fairly freely in one direction but not in the other. The resultant action is that of a rectifier.

A piece of copper, coated with copper oxide, assumes this barrier-layer property, and copper oxide rectifiers are widely used. A first cousin to this device is a unit made up of copper, a copper oxide barrier layer, and a film of translucently thin metallic silver. If these components are closely sandwiched together and the unit is exposed to light, a sensitive microammeter will show a considerable current. At present this arrangement is used chiefly in photographers' photoelectric light meters, but it is already in the cards that if electricity generated by light can be *measured*, it can also be *harnessed*! And Old Sol pours down enough light energy to illuminate the earth by night as well as by day!

In addition to the barrier-layer type of crystal, there is another prominent crystalline group distinguished by a property known as the piezoelectric effect. Piezoelectric crystals oscillate mechanically when struck, and the oscillation sets up an electro-



BARRIER-LAYER effects explain the operation of copper oxide rectifiers. The larger unit is used in a battery charger, the smaller in an ammeter.



COSMIC RAYS, oscillations above a quadrillion megacycles, top the frequency spectrum. Their presence can be detected by gas-filled Geiger tubes.

static field. Conversely an electrostatic field can set up mechanical oscillations in a crystal. Being a very stable oscillator, quartz crystal is widely used to control the frequencies of radio transmitters. Rochelle salts are employed in microphones to convert the mechanical pressure of sound waves into electric potential. Crystal earphones and loudspeakers reverse the operation and convert electrostatic potentials to sound.

Devices for converting energy from one form to another play a large role in the study of ultrafrequency radiations, and the bolometer is one of these. At first blush it may appear incorrect to include it in the category of instruments other than vacuum tubes, since most bolometers are enclosed in vacuum envelopes. The vacuum, however, is used to minimize gain or loss of heat and acts merely as a thermal or mechanical protector. The essential part of the bolometer is usually a blackened metal disk with a hypersensitive thermocouple; it absorbs all radiant energy in the wavelength band from short radio to long X-ray, converts the energy into heat, and measures the amount of heat so produced. Since heat is a function of energy, the bolometer actually measures the radiant energy in a considerable segment of the electromagnetic spectrum.

Where heat is either the original or end product of an electronic action, thermocouples are frequently used to detect the extent of radiation. They utilize a tendency of metallic atoms to lose electrons when excited by heat. Some metals release electrons easily; others do so with the utmost reluctance. If two metals with different retentive powers are closely connected and heated to the same temperature, the loose-electron metal will shake out the negatively charged

particles and the retentive one will grab them. This causes a flow of electrons, or current, which is proportional to the temperature. Thus high frequencies are converted to heat, which is then measured in terms of direct current by an ordinary meter.

Barring the secret and still unpublished discoveries of the war years, electronic devices that operate in the top half of the frequency spectrum are used primarily to measure and study the properties of electronic motion. Prominent in this class is the Wilson cloud chamber, a tube filled with gas and moisture in which movements of electrons cause ionization of the humid gas and produce electronic tracks that are visible to the naked eye. The Geiger tube, similarly, detects cosmic rays through the medium of ionized gas.

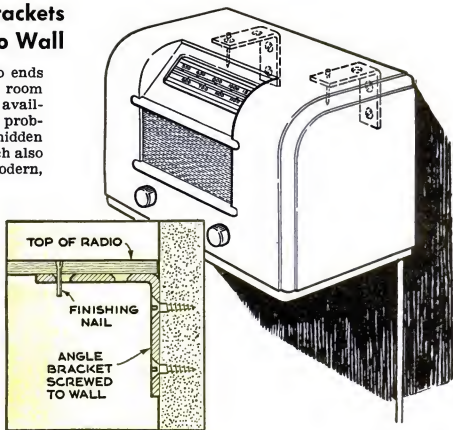
X-rays are electromagnetic radiations in the vicinity of a trillion megacycles; they are produced in nature by the disintegration of radium atoms, or electronically by bombarding a metal target with a beam of electrons at extremely high voltages. Although most X-ray tubes are enclosed in vacuum, as in the case of bolometers, this is an energy-saving convenience rather than an electronic necessity.

Electromagnetic vibrations are not, as is indicated by their name, entirely electrical. This can be demonstrated by magnetizing a bar of iron, cobalt, or almost any of their alloys. Depending on which metal is used, the bar will become longer and thinner or shorter and thicker. This phenomenon is known as magnetostriction and is a mechanical effect produced by magnetic instead of electric fields. Magnetostrictive oscillators analogous to quartz-crystal oscillators have been made.

Hidden Mounting Brackets Fasten Small Radio to Wall

ALL too often a small radio ends up at the wrong side of a room because there's no table space available where you want it. This problem can be overcome by the hidden wall bracket shown here, which also helps to give little radios a modern, "built-in" look. Its cost is negligible.

Before hanging your radio, be sure that the cabinet is sound and the joints are in good condition. Screw two angle brackets to the wall as shown. Finishing nails or small wood screws driven through the top of the cabinet will keep it from sliding off without preventing you from lifting it off when desired. Cut off the ends of the nails.—H. D. POST.

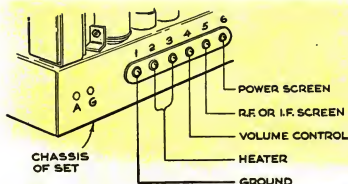


Terminal Strip Helps Experimenters in Testing New Circuits

RADIO experimenters who have to stretch available equipment can adapt a home radio set to supply current at different potentials for a variety of test instruments or "add-on" circuits. Six connections brought out to a terminal mounting strip at the back of the chassis will make it unnecessary to remove the set for every new experiment.

Connect the terminal points to the circuit element indicated in the drawing. Shield the No. 4 connection and hook it to the un-

grounded side of the volume control that connects with the A.F. input to the audio amplifier. Check your radio before making this connection, since not all volume controls are suitable for this use. For a handy continuity and condenser tester, attach a pair of prods in series with a neon lamp as shown. A record player may be connected to Nos. 1 and 4, or a complete crystal-microphone preamplifier can be fed directly into the power output stage.—E. E. YOUNGKIN.

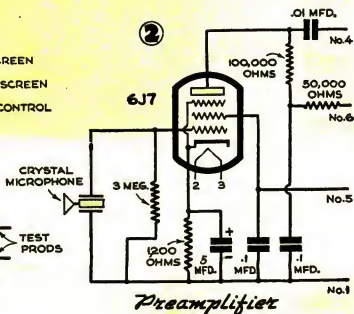


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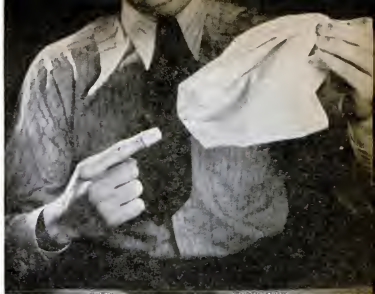
*Neon Lamp and
Continuity Tester*



Preamplifier

TABLE TRICKS

PULLING A THIMBLE through a handkerchief isn't difficult if you secretly use two thimbles, one fitting loosely over, and hiding, the other. With both on one finger, drape the handkerchief over them, reach under and remove the larger thimble, and put it on again over the handkerchief. Now grasp the handkerchief by the corners and whisk off the larger thimble. Your friends will be startled to see a thimble still on your finger.



ONE BLACK CHECKER in the center of a stack of six reds will change color at your command as you lower a tight paper tube over the stack and lift it off again. The black checker is really a fake—a red one over which a black paper ring fits loosely! Soap the tube to make the paper adhere.

FEW COAT POCKETS are designed to carry a full glass of water, and so friends will get a jolt when you pull one out and take a deep drink! They won't know you have kept it from spilling with a piece cut from a toy balloon and held on by a rubber band. Slip off the cover as you reach in your pocket, and steady the glass with your hand.

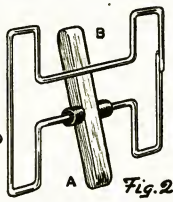
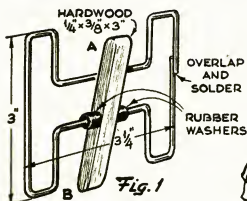


SPOTS BEFORE THE EYES of your friends will vanish mysteriously and return again if you work this trick with dexterity. Put a spot on the nail of both forefingers with a soft pencil or ink. Then sit at a table with the two spotted fingers extended on it and the others doubled into your palms. To make a spot vanish, raise your hand and, just as you are lowering it again, quickly double back the forefinger and extend the second finger in its place! Act quickly and keep the rest of your hand hidden.

DISAPPEARING PENCIL. Sit with a table between yourself and your audience and roll what appears to be an ordinary pencil loosely in a sheet of paper. Then tear the roll in two, unroll the halves—and the pencil will have disappeared! The pencil, of course, is a fake—a pencil-size roll of colored paper with the point and the eraser of a real pencil glued into the ends. Before unrolling the torn halves of the rolled paper, hold them low and let the ends of the fake pencil fall into your lap.



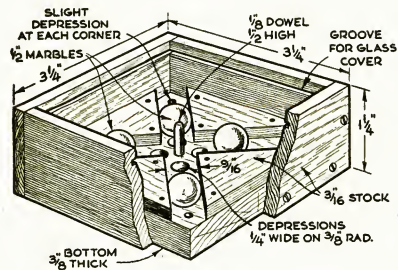
MAGIC YOU CAN MAKE



QUICKER THAN THE EYE, this trick fools many astute observers—at least for a time. The object is to make the hardwood strip, *AB* in Fig. 1, go through the wire and appear on the other side as in Fig. 2. It can't, of course, but you can make it seem to do so by pressing the wood against the frame and snapping

your finger off so the strip rebounds in almost a complete turn. Movement is too fast to be seen.

Slip on the washers and wood before bending the coat-hanger wire. Friction of the washers against the wood minimizes all but the desired rebound.—GEORGE BARR.

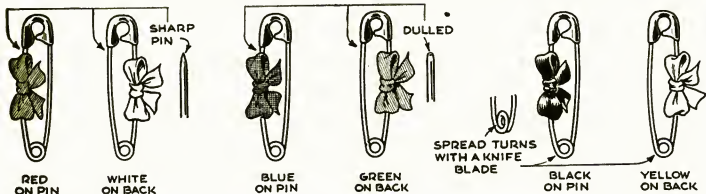


APPLIED SCIENCE, and nothing else, solves this puzzle. Make a box to the dimensions shown and cover it with glass. Now try to get the four marbles into the four corners at the same time.

Your friends who aren't in on the secret, or who don't remember their science, will twist and turn the box to no avail. One or more of the marbles will always run back toward the center. But centrifugal force will turn the trick. Just spin the box sharply, and the marbles will all run to their corners as if guided by some magic hand. Without this simple solution, the puzzle can be baffling.—G. B.

THERE'S A POINT to this trick done with six safety pins and a set of small bows of differently colored ribbons. Blindfolded, you can pick one of the pins from a hat, or have a friend put one in your hands held behind your back, and almost immediately you can name the color of the ribbon tied on it. The code is in the drawing below. Half the bows

are on the back of the pins, half on the pin side; two of the pins have sharp points, two have their points dulled; and two have the spring turns spread just enough to admit a fingernail. Your touch and the memorized code are all that you need. For instance, if the ribbon is on the pin side and the point is sharp, it's a red ribbon.—G. B.



Radio-Controlled Planes Tow Antiaircraft Gunnery Targets

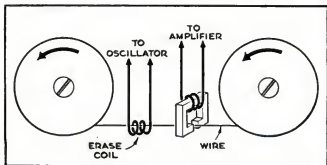


LONG envisioned as an ultimate weapon of war, radio-controlled robot planes have been put to use by the U. S. Army for towing targets that test the skill of antiaircraft gunners. As employed overseas by the U. S. Seventh Army, the robots are miniature high-wing monoplanes, powered by two-cylinder air-cooled engines having coaxial contrarotating propellers. The upper photo at the left shows two Army technicians trying out the radio controls before sending up a plane, which begins its flights on the portable launching ramp at the lower left. Since wind conditions usually make a conventional landing risky to the plane, it is landed by means of a parachute that is ejected at the touch of a remote-control button. The plane can be put through evolutions that closely simulate those of enemy planes, and gunners can track the towed target without the danger involved when piloted planes are used.

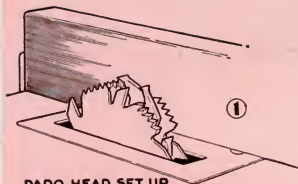


Wire Recorders Made in Pocket Size or as Radio Attachments

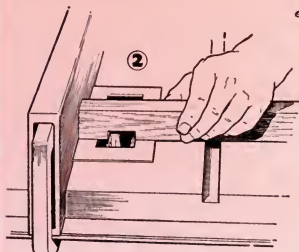
WIRE recorders like the one pictured at the right have been reduced in size and weight until they now fit the pocket and can be carried anywhere for on-the-spot pickups. Designed by the Armour Research Foundation, of Chicago, this 3-lb. battery-powered model magnetically records sound on wire almost as fine as human hair. For playback, the wire spools can be transferred to a larger device. The small instrument seen at the lower right, which attaches to a radio, is manufactured by Lear, Incorporated, of Chicago. It contains the circuit elements shown in the diagram and can be connected to a suitably fitted radio for recording, erasing of previous impressions, or reproduction of impressed sounds.



What's Wrong?



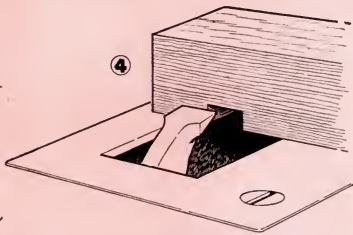
DADO HEAD SET UP FOR $\frac{3}{4}$ GROOVE



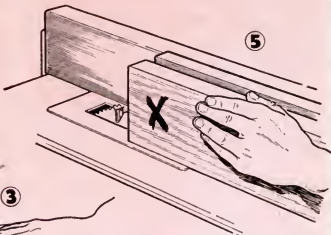
USING FENCE AS GUIDE IN CUTTING A DADO



GROOVING SHAPED WORK



USING CHIPPER TO CUT A DADO



GROOVING BENCH-TOP MEMBER FOR A SPLINE

THESE are all setups for the circular saw. Some would work after a fashion; others would not work at all. In each case there is a correct, efficient way to do

the job. Can you tell what's wrong? After you have written down your answers, turn the page upside down for the correct ones given below.

4. Chipper alone will not cut smooth dados. If a dado is too narrow for dadoes in combination, use one or both saws alone.
5. The working face of the stock should be pressed against the fence in cutting both grooves so equal distances from the face edges to the grooves will be insured. If grooved as shown, faced surfaces might be at different levels on assembly.

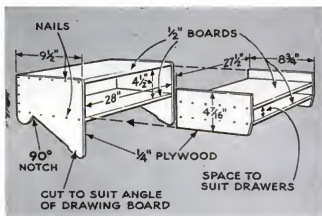
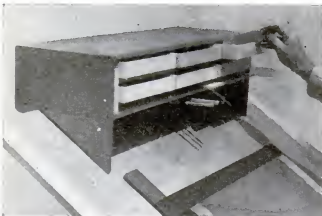
ANSWERS: 1. The chipper, or inside cut-
ters, are mounted backwards and will not
cut.
2. Narrow ends offer little support
against twisting, which might ruin the
work and injure the hand. The piece
should be held against a miter gauge.
3. A piece with a straight edge parallel
to the groove should be lapped to the top
of the work to slide against the fence.

Paint Can Becomes Sand Pail

IF YOU have a discarded paint container with the handle still attached, it can be transformed into an attractive and sturdy sand pail with little effort. Remove the rim with a close-cutting can opener, leaving no sharp edges, and clean up the can with paint remover. Give the exterior two coats of white paint and decorate with decalcomanias, paint the interior a light yellow, and the pail is ready for use on the beach or backyard sand pile.—MRS. W. A. BLACK.



Easel Filing Cabinet Keeps Drawing Materials Within Reach



DESIGNED to fit on the uptilted edge of an easel, this cabinet holds paper, instruments, and other drawing materials within easy reach. To keep down the weight, make it of $\frac{1}{2}$ " stock with plywood ends and use cardboard boxes for the drawers. If the

shelving is assembled as a unit so that it will slide into the shell, you will be able to alter the shelf spacing later if a new arrangement becomes desirable. The underside of the shell makes a handy spot for a coil-spring pencil holder.—J. MODROCH.

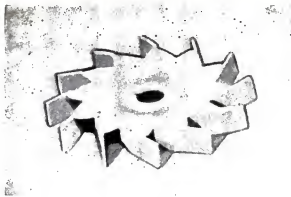


Pencil Clip Used to Paint Stripe

YOU can do a neat paint-stripping job with an ordinary camel's-hair brush such as used by artists if a pencil clip is slipped over the ferrule and clamped into the position shown at the left. The ball of the clip will serve as a guide, keeping the brush tip from dragging heavily across the work and making the stripe uneven. Use pliers in order to crimp the clip on.—SIGMUND SAMETH.

MORTISE AND TENON





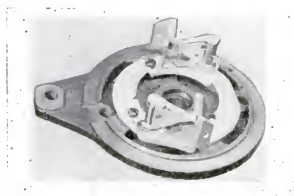
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4



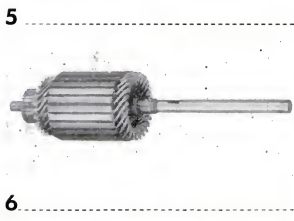
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5

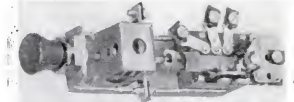


3



6

WHAT do you know about the electrical system of your automobile? One or two of the parts shown here may be puzzlers, but most of them will be duck soup for the driver who tinkers with his car. Write your answers in the spaces provided; then check them with the correct ones given upside down below.



7



8

1. Generator fan.
2. Headlight beam-selector switch.
3. Distributor contact points.
4. Condenser.
5. Generator end with brush-holder ring.
6. Starting-motor armature.
7. Light selector switch.
8. Generator armature.

ANSWERS

Photos courtesy Delco-Remy.

HOME EXPERIMENTS SHOW NEWTON'S

In 1686 Sir Isaac Newton formulated the principle that every action has an equal and contrary reaction. Jet-propelled planes, V-1 bombs, and rockets are among the latest applications of Newton's Third Law of Motion. These five experiments with everyday material graphically reveal the existence of this physical law.



WHEN TRAINS OR AUTOMOBILES travel forward, they push backward on the tracks or road. This manifestation of Newton's Third Law of Motion can be demonstrated with a toy electric locomotive set up on a board suspended by strings or wires at each corner so that it is free to swing forward or backward. When current is applied, the locomotive moves forward, as would be ex-

pected. But simultaneously, because of the reaction, the tracks and board swing in the opposite direction, as shown by the pointer. This force of reaction has been harnessed and put to work in such devices as treadmills and walking exercise machines. When these mechanisms are used, the effort that normally would produce forward movement makes the "ground" move backward instead.

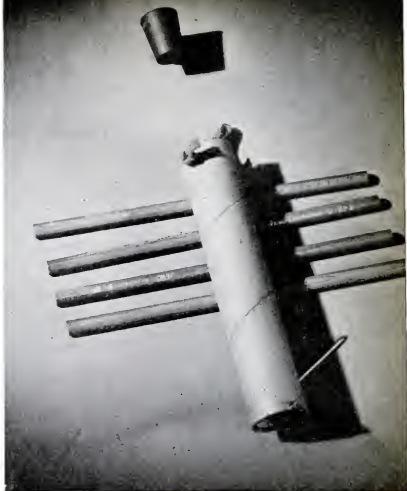
CROUCH ON A SCALE and notice your weight. Now, quickly raise yourself to an erect position, watching the scale dial as you do so. Momentarily, while you are rising, you gain a substantial number of pounds. Why? Because the action involved in giving yourself an upward velocity produces an equal reaction downward, and the latter is added to your normal weight. Converse-

ly, if you start from an upright position and squat down quickly, the force exerted on the scale will be considerably diminished and, for the time being, you will be many pounds lighter. This test of Newton's Third Law shows why you must stand still on a scale in order to read your weight accurately. A bathroom scale with a horizontal dial is ideal for the experiment.



THIRD LAW OF MOTION

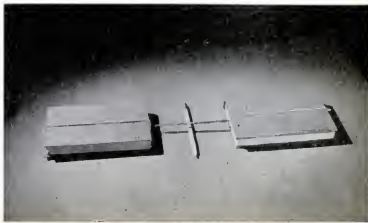
IF TWO OBJECTS are forced apart or pulled together, the momentum imparted to each is equal. This principle, called the conservation of momentum, also is a part of Newton's Third Law of Motion. You can demonstrate this with a toy gun made from a mailing tube and a rubber band. Place a loose-fitting rubber stopper against the stretched rubber band and hold it in place with a string looped over a nail across the end of the tube. Rest the gun on several pencils. "Fire" it by touching a match to the string where it passes over the nail. As the projectile flies forward, the tube rolls backward. If you could measure it, you'd find the backward momentum imparted to the gun was equal to that given the projectile.



HANG A WATCH on a nail and carefully balance it. If properly hung, the watch soon will begin swinging rhythmically—demonstrating that Newton's Third Law is operative wherever any motive force is involved. In this instance, the escapement action in the watch kicks back on the watch itself, just as a bullet speeding from a gun gives a backward kick to the weapon. Ordinarily, the inertia of the watch and the fact that it is kept from accumulating movement like a pendulum prevents this kick from being translated into actual motion.

TIE A STRING around each of two books of equal weight, and connect the two strings by means of several rubber bands linked together. Lay the books on a smooth surface, separate them so that the rubber bands are stretched, and place a marker exactly midway between them. If you release the books at exactly the same instant and

the surface on which they are resting is uniformly smooth, each will be drawn toward the marker exactly the same distance—another demonstration that action and reaction are equal. If one book were heavier than the other, the heavier would move a shorter distance, but the momentum imparted to each would be the same.



Carbon Dioxide...

THE BREATH OF LIFE

By Kenneth M. Swezey

YOU can't see it, smell it, or taste it, and the earth's atmosphere contains only three or four parts in ten thousand. Yet, without this trace of invisible, unsmellable, untastable carbon dioxide gas, life could not go on. By some miracle of synthesis which laboratory chemists have never been able to duplicate, green plants aided by sunlight wrest the carbon from carbon dioxide and combine it with water to form sugar and starch.

So that the supply of carbon dioxide may continue undiminished, nature has provided means of constant replenishment. Men and animals eat plants as food, oxidize this food, and give back carbon dioxide in their exhaled breath. The give-and-take is a never-ending process.

Breathing, of course, is not the only means of replenishing the supply of carbon dioxide in the atmosphere. It is produced when any substance containing carbon—coal, wood, oil, and so on—is burned. Decaying and fermenting plants also loose it.

Carbon dioxide is as harmless, in itself, to the human body as water, although a person placed in a pure concentration of the

gas would suffocate as surely as one wholly immersed in water. However, carbon dioxide (CO_2) is not to be confused with deadly carbon monoxide (CO), which can kill if only a small amount is present in air that is breathed.

Besides providing building material for living things, carbon dioxide is of great commercial importance. Because it is about one and one-half times heavier than air, does not burn or support combustion, and can be cheaply produced, carbon dioxide has become, next to water, the most important material for extinguishing fires. In solid form, it is the familiar "dry ice." In baking, it makes bread and cake light and more easily digested. In soft drinks, it provides zest and sparkle.

In the laboratory, the easiest way of generating this interesting gas is by reacting any carbonate or bicarbonate with any common acid. Because of its cheapness, calcium carbonate, in the form of small lumps of marble, limestone, or chalk, is generally reacted with dilute hydrochloric acid.

You can make a simple generator from a 500-ml. flask fitted with a two-hole stopper. Push a thistle tube, adjusted to reach nearly to the bottom of the flask, through one

Carbon dioxide will form if you pour hydrochloric acid through a thistle tube on water-covered marble chips in the flask at the left. The gas is washed with water in the center cylinder and collected in the jar. Baking powder, warm water, and gelatin produce the carbon dioxide foam in the tumbler at right.





Baking powder and acetic acid in a milk bottle make a working model of a carbon dioxide fire extinguisher.

hole and a short, straight outlet tube through the other. You can wash the gas by bubbling it through plain water contained in a cylinder or second flask. Since the gas is heavier than air, it can be stored merely by leading the delivery tube to the bottom of the collecting jar and by covering over the top of the latter with a piece of cardboard to minimize disturbance of the gas and air.

Operate the generator by carefully dropping in pieces of marble to a depth of about $\frac{1}{2}$ ", and add enough water to cover them well. Next, slowly pour hydrochloric acid into the thistle tube until gas begins to be evolved vigorously. Add further acid when the flow of gas diminishes.

One of the most common types of fire extinguishers is just a modification of this generator. For extremely rapid evolution of gas, however, the carbonate (usually sodium bicarbonate) already is in solution. When the extinguisher is inverted, concentrated sulphuric acid, contained in a loosely stoppered bottle, mixes with the bicarbonate. Carbon dioxide, quickly formed under considerable pressure, then forces the carbonated water out the hose.

With a milk bottle and a few bits of



glass and rubber tubing you can make a working model to demonstrate the principle of this extinguisher. Fill the bottle three-quarters full of concentrated solution of bicarbonate of soda (baking soda). Through a two-hole stopper thrust one end of a bent glass tube so that it extends nearly to the bottom. Through the other hole push a glass stirring rod to which you have attached, near its lower end by means of a rubber band, a small vial or test tube of concentrated acetic acid. (Acetic acid is safer to use in this experiment because it liberates the gas more slowly, thus eliminating the danger of blowing out the stopper or bursting the bottle.) A rubber tube connects a glass nozzle to the free end of the

bent tube. Adjust the stirring rod so that the open top of the vial containing the acid is above the level of the bicarbonate solution.

To put the extinguisher into action, push the stirring rod down until the vial is submerged. If the gas is not given off fast enough to force the liquid up the bent glass tube and out the nozzle, tilt the milk bottle a little so that the acid will run out of the vial. It is better not to invert the bottle completely, however. [Turn the page.]



Blow into a weak alkaline solution and carbon dioxide from your breath joins the water, forming carbonic acid that neutralizes the solution. Drive out the CO_2 , and the alkalinity is restored.

The heaviness and fire-extinguishing ability of carbon dioxide can be demonstrated by leading the gas into the bottom of a large jar containing several small lighted candles supported so that the flames are at different heights. As the gas pours into the jar and gradually fills it toward the top, the candles go out one by one, beginning with the one closest to the bottom.

Every time your wife or mother bakes, the bread or cake itself is a generator of carbon dioxide. The yeast put into bread contains an enzyme which acts upon the sugar and starch in the dough, producing tiny bubbles of carbon dioxide. Heat expands these bubbles, making the bread light and porous.

Baking powder, generally used to give the same sort of lightness to cake, consists of sodium bicarbonate mixed with some solid acidic substance, such as potassium bitartrate (cream of tartar) or sodium potassium

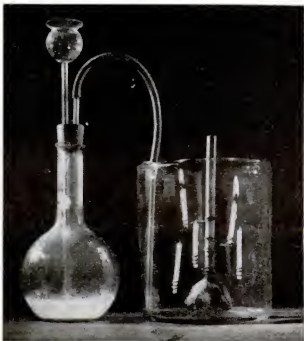
tartrate (Rochelle salts). When the baking powder comes into contact with moisture these substances react because their ions are freed by the presence of water.

You can demonstrate vividly the carbon dioxide generating ability of baking powder by putting a little in a tumbler and stirring with it warm water in which has been dissolved a trace of gelatin. Bubbles of carbon dioxide form rapidly and heap themselves up in the glass. The gelatin strengthens the bubbles, making them last much longer than they ordinarily would.

Similar blankets of carbon dioxide foam, produced by the reaction of alum and bicarbonate of soda and stabilized by gelatin or licorice, are an extremely effective fire extinguishing material. Such foam is used particularly in fighting oil fires.

When dissolved in water, carbon dioxide forms the weak and unstable acid, carbonic acid. You can prove that this acid is real, however, by neutralizing an alkaline solution merely by blowing into it. Dissolve a bit of lye or sodium carbonate in a test tube one-third full of water and add a drop of phenolphthalein solution. The solution will turn a bright pink, indicating an alkali. Now bubble your breath through the solution. The pink becomes lighter and finally disappears. That the CO_2 is only weakly tied up in the neutral salt, sodium bicarbonate, can now be proved by heating the solution. When the carbon dioxide is driven off, the pink color returns.

Generation of CO_2 when substances containing carbon burn is shown by the set-up at left. The siphon draws the gas, produced by the candle, through the cylinder containing limewater, which turns milky when insoluble calcium carbonate forms. At right, candles go out one by one as the CO_2 level rises in the jar.



"Tin Cans" Dish It Out

(Continued from page 134)

sponds to the order "Stand by to fire" by turning a training wheel, keeping the tubes in line with a red arrow. Above him in the fire-control tower, the torpedo officer plots the relative speed and course of the enemy ship and his own. Then he presses a firing key, and the torpedo leaps from its tube. It has been preset to travel at a depth that will do the most damage to its target—which might be five to 10 feet for another destroyer, or at least 20 feet for a battleship or aircraft carrier. On striking the sea, it automatically submerges to this level, and gyro-controlled rudders hold it on an absolutely straight course up to 6,000 yards, driven by its compressed-air motor and tiny twin propellers.

Early in the war, a division of U. S. destroyers, with one lone torpedo left among the four vessels, had the disconcerting experience of meeting a Japanese cruiser and its destroyer escort in the Java Sea. Instead of being able to attack, the American force was in danger of being sunk, if the Japs guessed its plight. So its commander ordered impulse charges to be fired in empty tubes, giving the same flash that the enemy would see if they were on the receiving end of real torpedoes. The bluff worked, and the ships of the Emperor turned tail.

Ask a veteran destroyer commander when he has come closest to death, as the writer once did, and he replies with a grin, "All the time." Odd jobs that destroyers perform often are as perilous as fighting. The U. S. S. *Maury*, whose battle log reads like a history of Pacific warfare, served as a tugboat in the midst of the last Japanese naval attempt to reinforce the Nips on Guadalcanal. Taking the disabled cruiser *New Orleans* in tow, the *Maury* brought her to safe waters through hostile fire and, because of reduced speed, imminent risk of submarine attack.

When waterlogged survivors from sunken warcraft are fished from the sea, destroyers usually are the rescue ships. A tin can is anything but spacious, yet the *Fletcher*—normal complement about 250—somehow managed to take aboard 700 officers and men from the sinking U. S. cruiser *Northampton* during the series of Solomon Island sea engagements.

When strategists set forth to show that every war weapon meets its match in a counterweapon, their favorite example is the torpedo boat versus the destroyer. Away back in 1860, admirals of the world's great naval powers were scared stiff by the invention of the Whitehead self-propelled tor-

pedo. Their peace of mind was by no means restored when Britain, in 1877, built the first torpedo boat to use the new weapon effectively. The steam-driven, 85-foot H.M.S. *Lightning* attained what was then the high speed of 19 knots, and carried a torpedo tube in its bow. Other countries adopted the innovation, and by 1890 the U. S. Navy possessed the 139-foot, 22½-knot torpedo boat *Cushing*, regarded as the top ship of her class.

What good were mighty armor-clads, long-time rulers of the seas, when craft of such insignificant size could sink them? Fuel was poured on the controversy when, during the Chilean civil war of 1891, a cruiser was sunk by a Whitehead torpedo.

The man with the answer was Sir William White, chief constructor of the British Navy. He proposed to build ships similar to torpedo boats but enough faster and more heavily armed to sink them. The result was the world's first torpedo-boat destroyer, H.M.S. *Havock*, a 180-footer of nearly 27 knots, armed with one 12-pounder, three quick-firing six-pounders, and three torpedo tubes. An immediate success, the ship was followed by the first U. S. torpedo-boat destroyer, the 210-foot, 27½-ton U.S.S. *Farragut*, which attained more than 30 knots—a record speed for reciprocating engines.

From the turn of the century on, engineering improvements came in rapid succession, and destroyers—having lost their longer name as they became major warships—gained in size and power. Our *Truxton* class of 1900 were 435-tonners. By 1909 our *Flusser* class, first American turbine-driven destroyers, and first to mount three-inch guns, displaced 700 tons. The first U. S. oil-burning destroyers, the *Conyngham* class of 1915, tipped the scales at 1,050 tons.

First to follow World War I, a new *Farragut* class of 1934-5 consists of 1,400-tonners, 334 feet long, armed with five 5-inch and four 40-mm. guns. Our last prewar destroyers, the 1,600-ton *Benson* class of 1940-1 now are supplemented by the 1,700-ton *Bristols*, the 2,100-ton *Fletchers*, and the 2,200-ton *Summers*.

Formerly, the limited cruising range of destroyers held back all the rest of the fleet. How we are currently able to pound at the gates of Tokyo can now be told. One means has been the fuel-saving use of high-temperature, high-pressure steam, first introduced in the U. S. Navy by destroyers of the *Mahan* class between 1936 and 1940. But perhaps the most important innovation is that of seagoing supply and repair bases.

Jungle Poison Saves Lives

(Continued from page 126)

Experts examined him from head to foot without finding anything wrong. Yet Gill lay in a hospital bed in Washington, D. C., unable to move and almost devoid of a sense of feeling. The doctors' best guess was that he was a victim of a type of spastic paralysis.

Persons afflicted with this ailment were sometimes shaken by muscular tremors and sometimes drawn into contorted postures by the tense rigidity of their muscles. Gill's doctor told him there was no known remedy for it, although a few promising experiments had been reported with an outlandish jungle poison, called curare. . . .

The name electrified the explorer. Suddenly, he felt that he had to get well and return to the tropics. From the Indians there, he might obtain enough curare so that these experiments could be continued and extended.

To learn to use his muscles again, he buttoned buttons by the hour and took other exercises recommended by his doctor. In a few months, he was able to leave the hospital. But four years passed before he was able to go back to Ecuador. Then he went as head of the Gill-Merrill Expedition.

Gill feared the witch doctors might have forgotten him, but they welcomed him heartily. With their help, he brewed curare; and with a fleet of a dozen cargo-carrying canoes he was able to transport it down the perilous rapids. After 10 strenuous months, he came home with the largest supply of curare ever brought out.

Gill also brought home motion pictures and still pictures showing every detail of the mumbo-jumbo manufacturing processes used by the Indians. For fully a century, commercial curare had been considered "a most unreliable drug." But the Gill-Merrill Expedition enabled scientists to standardize it—that is, produce a pure preparation with a known and definite potency and consistency, so that its effect on a patient could be foreseen accurately.

This was done first by Dr. A. R. McIntyre of the University of Nebraska. Independently, with 100 pounds of crude curare supplied by Gill, the drug was also standardized in the laboratories of E. R. Squibb and Sons. This company sent free samples to research workers throughout the country, and has since placed curare on the market under a trade name. Gill expects an additional product to be released soon.

In the meanwhile, the medical profession had been confronted by the necessity of making an extremely painful decision. Con-

vulsive-shock therapy had been developed as a means of curing certain mental ailments. Remarkable cures had been brought about. But the patients' convulsions were sometimes so severe that they injured themselves internally and even broke their own bones. Mental illnesses were being conquered at the risk of serious physical injury. Should such treatments be continued?

This grim controversy evaporated when curare was standardized—for this drug made it possible to continue convulsive-shock therapy without the grave danger of physical injuries.

Dr. A. E. Bennett of Omaha, Neb., was one of the pioneer users of the new drug. He employed it first in treating children with spastic paralysis. It did not prove to be a permanent cure, but brought about marked improvements.

Tests upon laboratory animals had shown that the drug relaxed muscles by paralyzing or blocking the connection between them and the motor nerves that energize them. Dr. Bennett's successes proved that curare could be used safely in the treatment of human beings.

The Nebraska doctor injected a curare solution into patients about to undergo the dreaded convulsive therapy. The results, to one who had witnessed "uncushioned" shock treatments, were spectacular. With curare as a shock absorber, the patients lay peacefully relaxed during the treatment. Best of all, the mental part of the cure was accomplished with undiminished success.

While curare itself is not an analgesic, or pain-killer, anesthesiologists have found it valuable in conjunction with standard anesthetics. They have used it to relax body muscles and provide conditions suitable for the intricate work of modern surgeons without administering toxic concentrations of the anesthetic. This may be one of its most important uses.

The scientific version of the witch doctors' dope has proved helpful, too, in the diagnosis of an often-fatal disease called myasthenia gravis, which is characterized by drooping eyelids, double vision, muscular fatigue, and nasal, husky speech.

The Indians who were the first to use curare do not employ it in warfare, because there are other ways of killing people. This drug is traditionally a means of helping hunters obtain food. Dr. Bennett calls it "the most powerful perfect muscular relaxant that is known." Now that it has been standardized by scientists, it may be helpful in many more ways.

Why Dice Behave as They Do

(Continued from page 123)

most likely to come up. This is done by trimming the sides slightly. Ordinary, cheap dice are rarely perfect cubes, so an unscrupulous player can take an assortment of store dice and select a pair which, because of their shape, will produce certain numbers more often than others.

The crooks do not expect to make their point every time, nor do they want to. They are well satisfied to have a good percentage in their favor.

The operator of a crap table in a gambling house has no use for crooked dice. He has the advantage in percentage against the guest who throws the dice, and also against those who bet on "the field," which is an important feature of all these tables.

The game of craps came to us from England and France, where it is known as hazard. What the Americans call "snake eyes," the double ace, is called "crabs" over there, and it is believed this is how we got the name of craps. Hazard was an outgrowth of a game played with three dice in ancient Rome and Greece. The Romans had names for the points, as our players do. The highest point was called "Venus" and the lowest "the dog." The Greeks called them "Aphrodite" and "the dog."

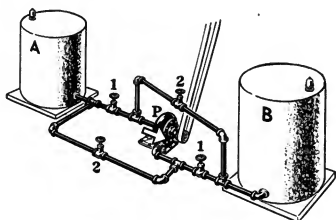
Dice games were played by all ancient peoples. Dice exactly like those with which we play craps have been found in Egyptian tombs. Some were made of ivory, some of baked clay. All down through the centuries, people gambled high stakes on the throw of these cubes. It became such a vice in England that the crown put a prohibitive tax on the sale of them. Strangely enough, this tax was discarded in Queen Victoria's reign.

Countless new games of dice have come and gone while the simple game of craps keeps going strong. This game probably owes its popularity to its simplicity. Anyone can learn the rules in about a minute, but the great majority of players do not take the trouble to figure out the odds.

The game of hazard is now played the same as craps. Formerly, the seven did not occupy the special place it now does in the game. It was a point like the others. The player called his point before he rolled. If he made the number called, he won; if not, the number rolled became his point, and the number he called became the hazard. Because of its mathematical merit, the seven was the number called most often, and in time it became the regular hazard, just as it is today.

SOLUTIONS TO BRAIN TEASERS

(See page 127)



PLUMBING EFFICIENCY

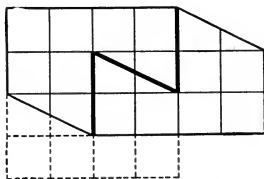
IF THE valves marked 1 are open and the valves marked 2 are closed, the oil will run from left to right. If the valves marked 1 are closed and the valves marked 2 are open, the oil will run from right to left. In either case, the oil always runs through the pump from left to right.

FOR TRIANGLE COUNTERS

1. 13 triangles. 2. 105 triangles.

GRANDMA DID IT EASILY

THIS is how she cut an odd-shaped remnant to piece out a square.



WIRED CUBES

1. Four pieces of wire.
2. One piece of wire. (Following the numbers on the drawing, this would be one solution: 1-5-6-7-8-5-3-7-1-2-6-4-8-2-3-4-1).

UNSCRAMBLING NEW YORK

There are several possible solutions to this. Here is one of them: 3-9; 11-10; 4-11; 1-4; 2-14; 15-1; 5-15; 12-5.

Plane of Many Faces

(Continued from page 105)

sweet job for any man's money." That's what the mechanics think of the Invader.

When you talk to the pilots you hear the same story from another angle.

"She's a lot of ship," one of them says. "She handles easy. Makes you think of a Havoc, in some ways, but she's got more power. Throttle action gets results right now, and I mean *now*. She's bigger, of course, but you can wheel her around like a Havoc, and that's saying something. Lots of climb, lots of speed, lots of maneuverability. And plenty of ceiling—plenty. She

gets away fast and she goes places in a hurry. She can take care of herself, too. Make no mistake about that. As for firepower . . ." He grins and lets it go at that. "You'll hear plenty from this ship, from all theaters. Plenty."

Then you ask the armorer, about her, and he looks up at all those guns and hunches his back, as though thinking of all that ammunition. Then he winks slowly, grins, and says, "There's sure a lot of fight in that ship. No matter what nose they put on her, she's a killer. She's one hell of a fighting ship."

Temple of a Thousand Steps

(Continued from page 111)

The small pyramids, about four feet high, at the top of the stairs, also may have been places to seek protection and stage sudden counterattacks. During a siege, ample supplies of water could have been drawn from the lake, Agua Azul.

Along the lower end of the lake basin, in front of the lower platform, there is an obstruction, or dam, composed of heavy stone rubble which probably was surfaced originally with cut limestone. It held the water in the basin above it, making that basin, in effect, a huge moat. The dam was wide enough to have been used as a causeway. Near the base of the temple there is a spillway, which still operates after a heavy rain. In the clear stream near by, other submerged stones have been found which may be the remnants of dams, bridge foundations, or retaining walls to channel the river waters. Hence, the Mayans appear to have had some knowledge of water engineering.

Behind the small pyramids on the upper platform, at the foot of the final flight of steps, there is an upright stone idol, now broken into four parts. This tablet, or stele, bears somewhat shattered hieroglyphs which, if Mayan custom was followed, indicate the approximate date the temple was completed. These markings have not been read with certainty, but authorities believe that the date on this stone falls within the first half of the fifth century.

From the high altar above and behind this idol, one can see, to the west, the large and exquisitely blue Lake Tepancoapan lapping the base of a mountain range. To the east, at least eight more blue lakes are visible through the clear, dry air. And, to the south, one sees a plain dotted with other ruins, Indian cornfields, brush, and short pine, rolling away to end at a moun-

tain range across the Guatemalan border.

The sky is startlingly blue, the clouds piled against it even more startlingly white. The stones and cliffs are white and gray, and the foliage green, brown, and red. Orchids and widow's veil can be seen everywhere and, hundreds of feet below the altar, there is the beautiful, still, blue, cliff-bound lake in whose cliffs were once entombed the remains of the holy men of the Mayans.

Evidence of the engineering skill of the Mayans in heavy stonework is found also in the ruins of Chincultic, across the old lake basin and less than two thirds of a mile from Agua Azul. There, evidence has been found that the Mayans understood the making of terra cotta, and made statues of it.

When Mexico's roads are improved and tourist travel is encouraged again, many Americans may find it fascinating to visit these and other spectacular ruins in this distant valley of the Sierra Madre. In my opinion, the whole idea of the Temple of a Thousand Steps, its orientation and location, presents us with a new conception of temple building which heightens our admiration for the ancient Mayan architects.

Aluminum Cloth Is On the Way

IT WON'T be long now before women's dresses and other articles of clothing, to say nothing of curtains and drapes, will be made of aluminum cloth, according to an announcement by the Aluminum Company of America. Several companies have developed the new fabric, which is made by laminating thin sheets of aluminum foil with an acetate plastic between. The cloth can be produced in all colors. It has unusual qualities for protection against both cold and heat, since it retains body warmth and tends to turn aside radiant heat.

My Sweetheart's a Black Widow (Continued from page 119)

of night; when you can climb away from the Tonys, Tojos, and Franks and turn with 'em; when she always brings you home from dangerous lone-wolf intruder missions; and when you know her cannons will knock out of the sky anything that flies and never jam—brother, you've got an airplane that's both safe and deadly. (Not until recent weeks did Black Widows carrying four .50 caliber machine guns in the top turret reach our squadron.)

Only in a plane designed and equipped for the purpose is the specialized and comparatively new operation of night fighting certain of success. The Widow carries in her two engines more than 4,000 horsepower—as much as a Diesel locomotive. Full-span flaps shorten take-off and landing distances, so we can operate from short fields, under fire. Retractable ailerons of the spoiler type shorten the turning radius and give us easy control at high speeds. Elevator booster tabs, unusual on a fighter, make it easier to actuate controls, especially in tight, steep turns. Usually, we need all their aid when winging away to protect a convoy or to stop the Jap before he can blast our own installations with machine guns and bombs.

No telltale tracers stream out from our guns. We make ourselves as inconspicuous as possible. We sneak in, kill, and run. By sneaking and striking, my squadron of 12 planes bagged 14 Jap planes in 11 nights over and near Mindoro, in the Philippines. Four of these, as luck had it, were mine—all shot down in a single night.

We moved from Morotai to Mindoro the day after Christmas to protect a new airstrip and cover invasion convoys moving north to Luzon. Gunfire from a Jap naval task force drove us away that night. I hovered over the Jap ships until long after midnight, keeping up a Clem McCarthy running account so that the B-25's and B-24's of the Fifth Air Force, and day fighters acting as dive bombers, could drop their loads on the best targets. Gas low, I pulled out to land at Valencia, near Ormoc, on Leyte on a grassy strip illuminated briefly by the lights of jeeps parked along the edges.

Early in the morning, I flew on to Tacloban, where I found the rest of my squadron's planes and crews safe. After refueling, we returned to Mindoro to take over night patrols and night convoy cover. At dusk and dawn, four-plane flights patrolled in regular fighter formation off the fringes of the convoys. Two patrols protected our base. After darkness fell, single plane flights

covered the convoys. Even in the moonlight, the hundreds of ships seemed to stretch beyond the horizons, a mighty portent of trouble brewing for the Japs on Luzon. We really pushed 'em those nights. The squadron's planes averaged 10 hours in the air. We flew halfway around the world every night.

With more than 100 night missions behind me, I long ago had overcome my dread of lack of vision. You don't fly these killers by the seat of your pants. You trust to your many instruments. I placed utmost confidence in both the plane and the instruments. You've got to trust 'em when the radio's silent, and you're up there in a void weaving around the sky three and four hours. It's a monotonous, lonely job—but fairly safe if you keep a cool head. The job, as the British say, calls for "dash with discretion."

Theoretically, you never shoot down an enemy plane by instruments alone. You need visual contact. On a bright, moonlit night, I found I could see a Jap plane a half mile away. When clouds or storm obscured the moon, I've sneaked up within 200 feet of a twin-engine bomber without being sure whether he was friend or foe. If he didn't reply with the proper code to our signal, it was "Katy bar the gate." Something awful would happen.

Business proceeded as usual until the night of January 7. That's when the cannons of my "Time's-A-Wastin'" got four—two Irving bombers, a float recon plane, and a Frank.

Three of us took off shortly before dusk and flew 50 miles south to cover a convoy of 300 ships. Thirty minutes after the light began to fade, I sent my two wing planes back, and continued my patrol alone. It was perhaps an hour later when the fighter director ship messaged: "Indications plane coming from southwest—8,000 feet—12 to 15 miles away."

I set a collision course, climbing and hoping to intercept the Jap at a safe distance from the convoy. I closed in fast, and first saw him two miles away, scudding toward a cloud. Both Phil and I identified him instantly: An Irving, similar to a Nick, only slightly larger. A deadly 20-mm. stinger in the tail, and three 12.9-mm. machine guns. Mustn't let him get in the first burst.

For seven minutes I chased the fellow. He turned in and out of the clouds. Gradually we descended. I hit him with a short burst as he entered one patch of cloud, and got away a second burst, the bullets striking

around the wing roots, when he came out in a turn. His tail stinger was chattering, but not for long. Down he dived, burning, to disappear completely.

The Irving was swallowed by the sea at nine o'clock, straight up. We circled only long enough for Phil to confirm the kill. I headed west, climbing to patrol altitude of 8,000 feet, to place myself off the west side of the convoy once more. Within a couple of minutes Phil spotted another one. "About 11 o'clock," he grunted. "Same altitude." I swung the plane a needle's width or so. Then I saw him, another Irving, etched against the moon.

He was so close to the convoy I had no chance to maneuver for a tail shot. I opened her up wide, in a head-on approach, diving to cut off the Irving before he started his bomb run. At 800 feet I cut loose with a three-second burst. Slugs bit into the canopy, others opened his fuel tanks. Several pieces flew off. The plane tumbled 1,500 feet and blazed merrily as it glided into the water.

By now, our gas was dangerously low. We landed to fuel, grab a cup of coffee, and snatch forty winks. The ground crew had no time to rearm the guns, but I figured we had maybe half the 700 rounds we had started with. Shortly before three we rolled off the dark runway to patrol locally. Our plane took the west sector. For a half hour we sat there, 20 miles off the island, "orbiting the beacon" in a 25-mile-long shuttle at "an altitude of expectancy." This meant 7,000, for the Japs had been coming over at 8,000 or lower.

Two in one night was a good score, I was thinking, when ground control broke into my thoughts: "Smith from Barr. Start letting down on course of three zero zero. Level off at three thousand." Minor changes came through rapidly: "Take course three two zero . . . new course zero six zero." The Jap apparently was coming from the north, offshore. Ground control was bringing me toward the coastline for an interception. "Course two seven zero . . . let down to 1,500 feet." Now Phil took over. "Let down," he shouted. "Steady . . . right . . . steady . . . haul off the coal!"

I throttled back. I had overshot. It was like trying to catch a greased pig. I almost had my guns on a Rufe, a single-engine navy float plane. But the Widow was too fast. For five minutes I circled over and around him. We were down to 200 feet. He maneuvered like mad. I'd pick him up, then lose him in a tight circle. I could almost see that pilot mopping his brow when I finally caught him against a light portion of the sky. I let the flaps half down, hoping their drag would cut our speed to 120. He

dived, but didn't seem to go anywhere. Then I let him have a short burst at 150 feet. His grave is unmarked.

Back once more on patrol course, I was certain the night would bring no more excitement. An hour groaned by. We had reached the north end of the course for the umpteenth time when the ground control broke the monotony. Something going north, vector zero two zero. That something, I learned later, had been strafing the base. The horse had been stolen, and it was up to us to lock the door so that particular thief couldn't sneak back another time.

Barr put us on him at 8,000. When Phil got a contact, I dived the Widow to 4,000, picking up speed to catch the fleeing fighter or bomber before he could escape ground control's range. I first saw him in the dusk-before-dawn 4,000 feet ahead and above us. Gradually I approached, directly on his tail. Phil formed a word with his lips: "Frank." Yep, we had a new-type fighter in our sights. I knew the Frank could hit 400 or faster. It's like the Zeke, but better.

Now I began to worry. Three kills already. How many rounds of ammunition had I used? Maybe I had a hundred left, and maybe I had only two or three. I had to get him with the first burst! Phil commenced calling off the ranges. When he hit 150, he peered out ahead. I could see the Frank looming up closer and closer. I closed to 75 feet. At that deadly range . . . Phil says we were closer . . . I hit the button. Twenty, 30, maybe 40 tapered steel slugs rammed into the Frank. As he exploded I chopped the throttle, dropping back to avoid most of the debris.

Dangerous? Foolhardy? Yes, I guess you'd call it that. But I meant to get him, and did. As it turned out, I might have taken a longer chance by firing from a greater distance. My crew chief reported later we had used 380 rounds for the night. I could have poured another 320 slugs into that luckless Jap.

Seven victories do not add up to a large total. That's not the real test of night fighting. Night fighters are primarily a defensive weapon, though they are sometimes used for train-busting and strafing ground installations. Our real job is saving airstrips and convoys from damage in the dark. As I said, few Jap planes have escaped once they blundered within range. That's the finest tribute I can write to the Black Widow. She's my sweetheart.

Subscribers in the armed services who notify us of change of address are requested to give us the key symbols appearing on the wrapper in which the magazine is received.

So you'll eat better



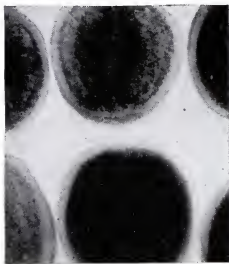
MORE FOOD from farms where electricity is a "hired hand" ...milking cows, pumping water, churning, grinding, increasing egg laying.

Earlier, better crops from electric hotbeds. Stronger, healthier calves ...when treated with ultraviolet. Better oranges ...with an x-ray playing "policeman" to toss out any below-standard orange. Food kept better ...with electric refrigeration. And better cooking ...with all those electric kitchen helpers you treasure.

Of course General Electric isn't really in the food business. But you can hardly find a farm, a factory, or a home where G-E research and engineering haven't helped get things done better. *General Electric Company, Schenectady, N. Y.*



"Floating drugstore" feeds 2,000 sailors. Ice cream aplenty on battle-wagons and most combat ships is now made on equipment recently developed by The Bureau of Ships, Bastian Blessing Company (who built the freezers and cabinets), and General Electric (who built the refrigeration equipment).



Which is the good orange? By inspecting oranges with G-E fluoroscopic units after severe frost, California and Arizona citrus growers salvaged millions of good oranges that would have been condemned by other methods. (The unfrozen orange is the dark one at the bottom of the picture.)



Ultraviolet for calves. Ultraviolet lamps make calves grow faster, healthier. Laying hens and baby chicks are also helped by such G-E lamps. Scientists and engineers at General Electric have devised electrical equipment to do dozens of different farm jobs from corn shelling to soil sterilizing.



Vitamin detective. Nutrition expert Dr. Jennie McIntosh works on experiment to determine best way to retain vitamins in cooked foods. This is one important project of General Electric's Consumers Institute. Discoveries are made public, and also are used to improve G-E kitchen appliances.

Hear the G-E radio programs: *The G-E All-girl Orchestra*, Sun. 10 p.m. EWT, NBC — *The World Today news*, Mon. through Fri 6:45 p.m. EWT, CBS — *The G-E House Party*, Mon. through Fri. 4:00 p.m. EWT, CBS.

FOR VICTORY—BUY AND HOLD VICTORY BONDS

GENERAL ELECTRIC

JULY, 1945

Buy War Savings Bonds and Stamps regularly.

209



EVER LOOK A FILE

"IN THE TEETH"?

TIME was when a file was simply a "many-toothed implement for abrading the surface or edges of metals and other materials." Today, with Nicholson setting the pace, files are highly specialized. Research and experiment have produced literally *thousands* of kinds, cuts and sizes—each designed for some particular type of material and operation.

Oddly enough, it is in their minuter details—the *teeth*—that files have one of their most important distinctions. Look at the teeth of different files through a microscope or magnifying glass. Height, thickness, spacing, angle, type of edge, relative depth of overcut and upcut—all make for incalculable combinations and characteristics. For instance, in Nicholson patented serrated-tooth construction, used on certain files, the teeth themselves have "little teeth"—to provide successive cutting edges.

"Know your files" is important in the training of a first-class mechanic. The Nicholson book, "*File Philosophy*," will prove helpful ... 48 interesting illustrated pages. *Free*.

NICHOLSON FILE CO., 19 Acorn Street, Providence 1, R. I.
(In Canada, Port Hope, Ont.)

NICHOLSON
FILES FOR EVERY PURPOSE
NICHOLSON
U.S.A.
MADE IN U.S.A.

Jeep with Wings

(Continued from page 96)

went into action on Guam. Under the command of Maj. Gordon W. Heritage, of Washington, D. C., it was based on a CVE, an oil tanker converted into a carrier. The ship lay off Guam for three days while the leathernecks went in over the beaches. Then the planes took off to establish a base at an improvised landing strip on Orote Peninsula.

They had to land on a makeshift runway because air and sea bombardment had pulverized Agana Field, the Jap airstrip. From 3,000 feet away the Japs were lobbing shells from mortars and spraying the area with machine-gun bullets. The airjeep crews slept, when they could, behind bulldozers.

Daily they flew behind the Japs' front lines. Within ten seconds after they took off they were over enemy-held ground. Winging just over the tops of the trees, they helped shorten the Guam campaign by days by directing the fire of 27 batteries of Marine artillery, each with 12 guns.

One pilot caught the glint of sun on steel as he flew low over the jungle. He ordered a concentration of fire. It cost the Japs three big guns, 60 trucks, and 400 officers and men.

In Italy, during the European war, airjeeps were used to lay telephone lines between command posts and forward observation positions in mountainous country that was hard to get to. The airjeep pilots unreeled wire as they flew along.

In Burma airjeeps evacuated 400 wounded British and Indian soldiers cut off by the Japs on the Arakan front. From a hastily built landing strip they had to fly nearly 1,000 miles in short hops back to their home base.

In Algiers, an airjeep pilot sighted a herd of gazelles roaming the countryside behind the coastal hills. He organized a hunting party and dropped several of the animals with rifle fire from the air. A retriever in a ground jeep collected the meat. Camp cooks featured "gazelleburgers" on the menu.

One airjeep was credited with downing a Messerschmitt fighter. When the Nazi got on his tail the airjeep pilot flew into a dead-end ravine. Turning in a circle hardly wider than the span of his own wing, the American pilot watched the German, unable to maneuver out of the hole he had bungled into, crash.

For two months airjeeps were used to keep traffic rolling on the congested "Red Ball Express" highway line between Cherbourg and Paris before American engineers

(Continued on page 214)

How a U. S. Warship won a tank battle

It happened during the invasion of Sicily . . .

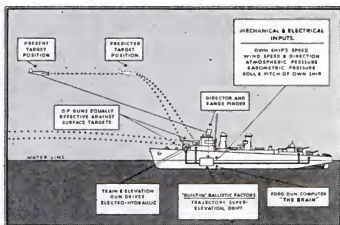
U. S. troops had landed. Before they could get tanks and artillery ashore, Goering's Grenadiers staged a savage tank attack.

Suddenly, five-inch shells began bursting among the surprised Nazis. Tank after tank was picked off with deadly accuracy, and the remaining tanks scurried for cover. Goering's Grenadiers had suffered a sound thrashing.

And somewhere out in the Mediterranean the jubilant gunners of a U. S. destroyer polished up their 5-inch "DP" guns—and decorated their ship's trophy panel with silhouettes of Nazi tanks!

"DP" is the Navy designation for *Dual Purpose*. Those five-inch guns can fire at surface targets, but they are equally deadly anti-aircraft weapons.

The secret of their ability to perform either task with devastating efficiency is the Navy's



How the Ford Gun Computer helps make the Navy's fire-control system equally effective against aircraft and targets on land or sea.

system of fire control, based on a number of precision instruments and controls.

The "Brain" of the system—an incredibly nimble, accurate, and tireless one—is the *Computer*, located far below decks where it is protected by heavy armor plate.



The Computer was developed over a period of years by the Ford Instrument Company, a division of Sperry Corporation, working closely with Naval engineers. In use, this device receives a bewildering aggregation of fire-control data from a Rangefinder, a Director, and other precision instruments.

In a split second it automatically solves mathematical problems that would occupy a mathematical wizard for hours. The solution of the problem is transmitted to the ship's batteries through the "brawny arms" of Electric Hydraulic Gun Drives which train and elevate the guns and keep them on the target.

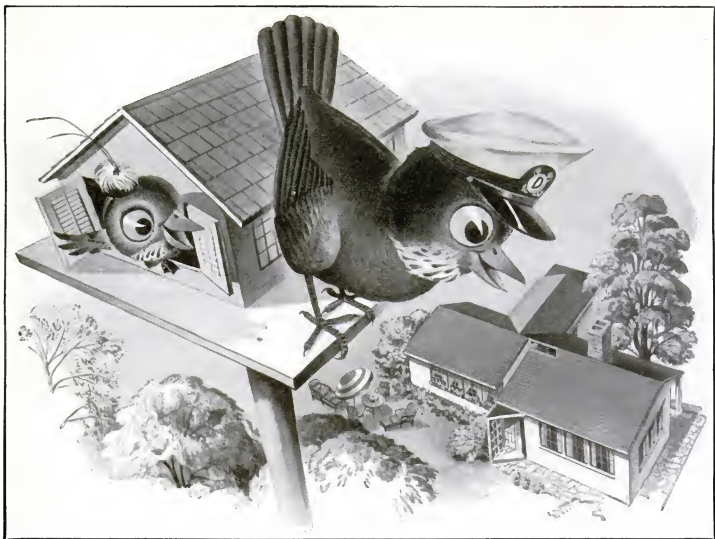
And that is why gunners of the U. S. Navy can lay a string of hot bursting, high-caliber projectiles along the path of an enemy bomber or torpedo plane . . . as well as pick off a tank miles away on shore.

That's why our Navy is the fastest, straightest-shooting Navy in the world!

SPERRY

CORPORATION
30 Rockefeller Plaza, New York 20

FORD INSTRUMENT CO., INC.
SPERRY GYROSCOPE CO., INC.
VICKERS INCORPORATED
Waterbury Tool Division, VICKERS INC.



Bird's Eye View . . .

JUST looking at the outside, as Defoe's little feathered home-builders are, can't possibly convey any idea of the comforts and advantages which are being perfected for your postwar home!

● ● Many new features that will save hours of tiresome housework are among the advancements in functional design, planned by Defoe's Housing Division for homes of tomorrow, large and small. These scientific

cally planned Defoe home-units will offer not only beauty and individuality of design but also the financial advantages made possible by modern mass production methods.

● ● And remember that today, while you're investing in War Bonds to do your part in winning final Victory . . . you're also steadily adding to the nest-egg that will help to finance your future home, when you're ready to buy or build it!

COPR. 1945 DEFOE SHIPBUILDING CO.

HOUSING DIVISION-DEFOE SHIPBUILDING CO.,

BAY CITY, MICHIGAN

BACK THE ATTACK
—BUY WAR BONDS

Defoe

SHIPS FOR VICTORY
SERVANTS FOR PEACE

☆☆☆☆ Five White Star Renewal
Citations now decorate the Navy "E"
Award won by Defoe workers.

**FULL STRENGTH
HORSEPOWER
FOR YOUR CAR**



CASITE

**Guarantees better and smoother
performance or double-your-money-back**

CLEANS OUT MOTORS • KEEPS MOTORS CLEAN

Ping . . . Sputter . . . Cough . . . Knock . . . your motor needs a Casite clean-out. At your service station, car dealer or garage—a pint in the crankcase every oil change and a pint through the air intake every three months.

GUARANTEE—Add Casite to crankcase and run through air intake according to instructions, then drive your car 100 miles or for 60 days, whichever is first. If not convinced that Casite gives you better and smoother performance, you get double-your-money-back by filling out guarantee certificate and mailing to The Casite Corporation, Hastings, Michigan. Maximum refund is \$1.30 per pint, twice the nationally advertised price of Casite.



**65¢
A PINT**

LESS WORK!

Because My Floors Stay Lovely Longer!"

Why make yourself extra work doing floors over and over every few days? Use Self-Polishing Simoniz. It saves you plenty of work because it's so amazingly tough and wear-resistant. Wears ever so much longer than ordinary polishes, yet nothing ever made your floors look lovelier. Nothing easier to use, either; no rubbing—no polishing—just pour, spread and let dry. In twenty minutes your floor sparkles with the same lasting loveliness that makes Simoniz so perfect for automobiles. Cleaning, too, is worlds easier. A damp cloth whisks up dust and dirt, and your floors shine like new again. Why not enjoy this blessing of lovelier floors with less work? Get Self-Polishing Simoniz at grocery, hardware, drug, paint or department stores.

THE SIMONIZ COMPANY
CHICAGO 16, ILL.



SELF-POLISHING

SIMONIZ FOR FLOORS

Jeep with Wings

(Continued from page 210)

got the French railroads into operation. Cruising back and forth above the narrow ribbon of pavement, they radioed word of traffic jams to the engineers charged with keeping trucks moving.

The versatility of these lightplanes was proved anew by Lt. Col. John C. L. Adams, an infantry officer, during the invasion of southern France. Twice he landed behind the German lines in an airjeep to make personal contact with the commanding officers of units that had been cut off.

Occasionally, airjeeps were fitted with bazooka barrels on the under surface of their wings, and the pilots attacked extra-tough enemy gun positions with rockets. A variation of the installation is a small barrel platform on each wing strut. The bazookas are fired with lanyards. One pilot on the European front killed off targets as big as German Tiger tanks (P.S.M., Feb. '45, p. 84).

The Germans, British, and Russians have used their own types of airjeeps in a variety of ways. It was a slow German plane of exceptional performance, called a Storch, that snatched Mussolini from Allied captivity. Both the Germans and the British used lightplanes to land saboteurs.

Red Army lightplanes were used to string parachute flares that guided tanks to weak spots in the German lines during the campaign in the southern Ukraine. The Russians arm their airjeeps. They used them for bombarding German artillery positions.

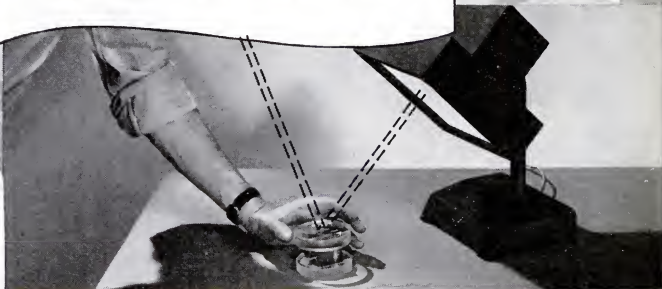
Fast thinking by a grasshopper pilot probably saved the life of Gen. George S. Patton in a close call on the European Front. "Old Blood and Guts" was taking a look at the battlefield from a small liaison plane when a German fighter dived at it with all guns blazing. Patton's pilot dropped the grasshopper to treetop level, and the Nazi, unable to pull out of his dive, crashed in flames.

Airjeep crews are proud of their outfits and their planes, and they sometimes look on the exploits of men who fly bigger, heavier planes with an ironical humor. One squadron in Italy organized a "bombing" mission of eight planes. The ammunition consisted of five-gallon tins of gasoline. Over the target, a German airfield, they solemnly unloaded their "bombs."

Back on their home field they wrote a report: "We failed to shoot down 120 enemy planes. We did not obliterate the target, and, despite flak which was not thick enough to walk on, we did not start fires visible for 80 miles."

Ingenious New Technical Methods

Presented in the hope that they will
prove interesting and useful to you.



Now! Shop Measurements to One Millionth of an Inch With Simple Light Wave Setup!

The wave length of light is the basis for this amazing new optical measuring equipment—which measures millionths of an inch as easily as a micrometer measures tenths! All that is required, in addition to a simple setup, is average eyesight, intelligence and arithmetic.

As shown above, the work was placed under the Monochromatic Light, upon the work and gauge block—and covered by the optical flat. The light, reflected back to the operator, by the top and bottom surfaces of the optical flat, creates interference bands, representing height intervals of 11.6 millionths of an inch. So that from the center of one dark band to the center of the next, the level of the work has risen or fallen 11.6 millionths of an inch. The bands, simply, are a contour map of the surface. This fact, in a simple mathematical formula, is sufficient to explain all the shop uses of optical flats, and give the work measurement, quickly and accurately.

No longer, however, can your dealer give you Wrigley's Spearmint Gum. Today, under present conditions, this product cannot be manufactured up to Wrigley's quality standards. To protect consumer and dealer alike, the makers of Wrigley's Spearmint have decided to keep the quality Wrigley's Spearmint wrapper empty. Remember this wrapper, it means chewing gum of finest quality and flavor.

You can get complete information from Acme Scientific Division
of Acme Industrial Co., 200 No. Laflin St., Chicago 7, Ill.



The Monochromatic Light.



Optical Flat. Surface of Work.
Interpretation of bands on
truly flat surfaces.

Z-73

Imagine-a ONE POUND Work Horse



James Watt established the term "horsepower" as the work output of a strong truck horse, weighing perhaps 2,000 pounds or more. A Cyclone 18, roughly equal in weight, is capable of 2,200 horsepower. If the truck horse were as efficient as the Cyclone, he would weigh exactly one pound.

All aircraft engines must have a low ratio of weight to power. If engines are heavy, the loads carried aloft are small. Lighter engines mean larger payloads. Of all aircraft engines, the champion is the Cyclone 9, the only service engine weighing less than a pound per horsepower.



POUND OF METAL: A horseshoe and a gear for a Cyclone weigh one pound each. On the horse, this metal is just dead weight, for protection. A Cyclone uses this pound of metal, in high-grade alloy form, to develop the energy of a 2,000-pound horse.



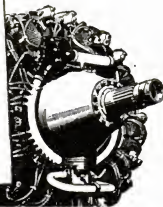
609 HP AUTOMOBILE: The motor of a popular modern car weighs 609 pounds, delivers 90 HP. If it were built to Cyclone design, it would turn up 609 HP for that weight. Most automobile engines weigh from 6 to 10 times as much per horsepower as Cyclones.

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AIRCRAFT ENGINES

DIVISION OF

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FIRST IN FLIGHT

CHAMPION

SPARK PLUGS INSURE

DEPENDABLE ELECTRICAL

ENERGY *In the B-29*

Far back in the tail of the mighty Boeing B-29 is an Andover Auxiliary Power Unit equipped with Champion Spark Plugs, for generating electrical energy for the more than 140 electric motors which perform a great multiplicity of vital functions in this ship. On a combat mission this is what the power from this engine does: It starts the main engines . . . changes the propeller pitch . . . raises and lowers the giant dual wheels and landing gear . . . opens and closes bomb bay doors . . . operates the flaps and brakes which slip out of the airfoil . . . runs the bomb sights . . . releases the bombs . . . turns the gun turrets . . . computes the gunner's sighting . . . fires the guns . . . and detects ground units . . . plus providing light and heat for the crews . . . and power for radio and intercom phones. Dependable Champion Spark Plugs here, as in hundreds of other vital war-time assignments, are adding new prestige to their reputation for better performance and greater dependability, in every engine. Champion Spark Plug Company, Toledo 1, Ohio.



Andover Auxiliary Power Unit as used in the B-29. Built by Andover Motors Corporation, and the Ranger Aircraft Engine Division of the Fairchild Engine and Airplane Corporation.

TO SAVE
GASOLINE
—KEEP SPARK
PLUGS CLEAN

DUST INVITES GERMS



Ordinary dust raised in sweeping carries myriads of germs which can remain virulent for weeks and even months. That is one reason why thousands of factories, shops, stores, and schools are adopting "Dustless" sweeping. Daily sweeping with a Dustless brush and Arbitrin sweeping fluid reduces bacteria in the air as much as 97%. You ought to know all about this better method of sweeping. Write for complete facts today.



- Dustless
- Speed Sweep
- Speed Wash brushes

MILWAUKEE DUSTLESS
BRUSH COMPANY

528 N. 22nd Street • Milwaukee 3, Wisconsin

Prison-Camp Ingenuity

(Continued from page 67)

ting needles out of bucket handles, then knit scarfs, sweaters, and gloves, to have something to swap. One man made himself a tin suitcase, and another built a toy steamboat that ran on a spoonful of margarine.

Desperate amusement seekers made kites out of toilet paper, until the Germans declared this sport *verboten*. Then, lying in his bed one day, Major Orris saw a fly come in his window with a glider in tow. It was a tiny piece of paper, folded the way school-boys fold sheets into toy airplanes, and attached to the fly by a thread. From then on, the imprisoned airmen had glider contests with the flies as tow planes.

During his year in Hitlerland, Orris saw only two movies. One was from Hollywood, "The Male Animal," and the other a propaganda film about the beautiful scenery in Germany. "You can imagine how we felt about *that*," he grins. But the kriegies made a curtain by sewing blankets together and put on stage shows for themselves. A loud-speaker blared German broadcasts at them, and they published two camp newspapers, lettering them by hand and posting them on the wall.

At Christmas, the kriegies scraped wax from the paper wrapped around food and made candles. Major Orris thinned the paint from a box of children's water colors and decorated his window. Soon, nearly all the windows in the camp were gaily painted, but the prisoners got no "bash" (extra big meal) on the holiday.

By January, they could hear the guns on the Eastern Front. The camp was near the Oder, and the Russians were coming that way. On an hour's notice, in the middle of the night, the kriegies were marched out into a snowstorm, with the temperature 10 below zero.

All the rest of the night, led by a horse and wagon, they marched three abreast in a column more than a mile long. Trails of blood were left by the bleeding feet of the horses and the guards' dogs. When a plane swooped low as though about to strafe the marchers, some men dived toward the woods, and the guards opened fire on them. Stragglers, whether guards or prisoners, were just left behind. One guard carried his police dog in his arms for warmth; other guards fell in the snow.

Polish women enslaved by the Nazis looked out of a factory window that dawn and wept when they saw the bedraggled, motley line of prisoners tramping down a

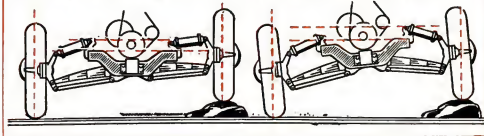
(Continued on page 222)

LIFE SPAN OF LUBRICANT VITAL in making your car "feel" better

Chassis lubricant can rapidly grow old on the job. Time and the effects of oxidation can gum it up or dry it out to the point where it's useless as a lubricant. Then your car no longer rides smoothly — a sure sign of the onset of wear. And no wonder! Here's what happens:

Proper lubrication permits independent vertical motion of wheel riding a road irregularity.

Improper lubrication tends to bind shackles, causing wheel and chassis to move vertically as a unit.



You can avoid the danger of prematurely worn bearings by having your car chassis lubricated with Marfak because this Texaco

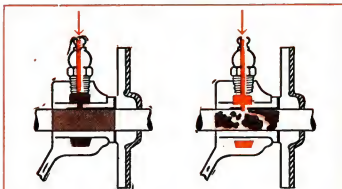
lubricant has an exceptionally long life span.

The drying of lubricants also results in clogged bearings that resist the injection of fresh lubricant, or bearings that remain partially caked with dried-out lubricant, as illustrated at the left.

However, Marfak chassis lubricant is scientifically designed to remain fresh over long periods, to resist oxidation, and to stick to the job. You can *feel* its cushioning effect as you drive — assurance that your car chassis is protected against wear. Marfak is both cohesive and adhesive; that is, it clings to bearing surfaces and, in addition, resists any tendency to wash out, jar out or squeeze out.

Protect and economize by changing to Marfak today! It will help keep your car on the road!

THE TEXAS COMPANY



A clogged bearing can not take in fresh lubricant. Unless it is cleared, the bearing will bind and eventually freeze.

Dried-out lubricant caked on portions of a bearing will cause uneven wear, chattering and eventual destruction of the bearing.



Don't miss the **TEXACO STAR THEATRE** on Sunday nights with **JAMES MELTON** and famous guest stars. See your newspaper for time and station.

You're welcome at **TEXACO DEALERS**





Enjoy Life with

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HIGH LIFE



MILLER BREWING COMPANY • MILWAUKEE, WISCONSIN

BIRMINGHAM, ALA.
Mean Average Temperature 53.9
During Heating Season

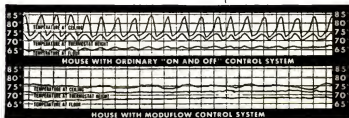


IS YOUR CEILING 750 miles FROM YOUR FLOOR?

Believe it or not, there is probably greater difference between the temperature at the ceiling and floor of your house than there is between the average temperature of Chicago and Birmingham, Alabama — 750 miles farther South. For, in the average home or apartment, the temperature at the ceiling is often twenty degrees warmer than at the floor. (See chart below.) Unfortunately, the heat that rises to the ceiling is largely wasted, while the floor may be drafty and too cold for comfort or health.

But, Minneapolis-Honeywell has devised a remarkable new heating control system that will correct this situation. It is called MODUFLOW. By an ingenious method of heat control and supply, Moduflow nearly equalizes floor and ceiling temperatures; result, uniformly comfortable temperature from ceiling to floor.

Every home or apartment, however modest, can afford the greater comfort and efficiency of Moduflow. Mail the coupon today for free booklet that tells all about Moduflow.



See the difference — Shown above are actual temperature recordings taken in two identical test houses — one with and one without Moduflow. Without Moduflow,

temperature varies as much as 20 degrees from floor to ceiling. Note how MODUFLOW smooths out the ups and downs of the ordinary system.

MODUFLOW

The New HONEYWELL Heating Control System



CHICAGO, ILLINOIS
Mean Average Temperature 36.4
During Heating Season

Free! SEND FOR THIS BOOKLET

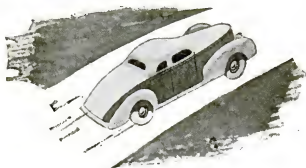
Minneapolis-Honeywell Regulator Co.
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Minneapolis 8, Minnesota
Please send my free copy of "Heating and Air Conditioning the Postwar Home"

Name _____
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Keep them Winning — Buy MORE Bonds!



CLEAN ENGINES



LAST LONGER



Smooth running, long lasting power requires a clean engine—an engine free of sludge, gum and acid which accumulate in the lubricating system and cause the motor to become sluggish and unresponsive. These petroleum residues are a major factor in destroying engines.

LOOSITE and **SILOO**, swift-working solvents of petroleum residues act quickly and safely to eliminate sludge, gum and acid. **LOOSITE** cleans out the engine—then **SILOO** added to fresh crankcase oil keeps it clean. A simple, harmless, economical method of obtaining maximum performance and longer life from your car.

Preservation of today's irreplaceable motors is vital—so ask your garage, service station or auto dealer for the **LOOSITE** and **SILOO** treatment—then notice the way your engine responds. Your car will run better and last longer.

If you heat with oil—write for information on
SILOO FUEL OIL TANK SOLVENT.

PETROLEUM SOLVENTS CORPORATION
331 Madison Avenue, New York 17, N. Y.

Prison-Camp Ingenuity

(Continued from page 218)

side road. The men were billeted that day in a barren, dusty room over a pottery works; other days they slept in barns, and once on a woodpile. The snow turned to rain, and the crude sleds on which some of them dragged their packs had to be discarded.

Many had fatigue visions of rosy sunsets, fireworks in the sky, and beautiful green pastures. Eventually they were herded into cattle cars. The 50 men in the car with Orris found they could all lie down at once if they carefully knit their bodies together, and they jolted on across Germany to Nuremberg.

There the weary, underfed, sick, and dirty men were soon covered with vermin and bites, because the cells into which they were dumped had not been cleaned. They received fewer Red Cross parcels, and the soup was often full of weevils. "The more weevils we got," says the Major, "the better we liked it. That was our meat ration." Some of the men became so weak they seldom left their bunks. "They blacked out," Orris explains, "if they stood up quickly."

American planes bombed the big railroad yards just beyond the prison fence. At Sagan, some men had been shot for rushing out and showing enthusiasm during air raids. But here they were allowed to sit on the sandbags and watch the fireworks while the guards ducked into slit trenches.

Major Orris and another kriegie escaped while being marched out of this camp, fled to the woods, built themselves a lean-to, and waited. They were afraid they'd be caught if they moved on—and Patch was coming toward them.

For two weeks they waited, listening to the guns, and living on scraps of food left by German troops who camped near by. They found other escaped prisoners in the woods, and played bridge two evenings with a couple of Englishmen. But the days seemed endless, so they risked moving on toward the northwest—and almost ran into a tank concealed in the brush.

Neither of them had ever seen that kind of a tank, so they supposed it was German and backed away fast. But when they peeked out farther on at an autobahn, they saw a long column of such tanks rumbling toward them—and the faces beneath the helmets of the men on the first tank were black.

"We just about cried," says the Major, "because when we saw that they were Negroes, we knew we were free."



Quiet

Quiet in fractional H. P. motors means minimum vibration. *Quiet* indicates to the engineer precision dynamic balance, rigid adherence to close tolerances, modern manufacturing methods and equipment.

These factors, plus suitable mechanical and electrical design, characterize BALLENTINE MOTORS.

BALLENTINE MOTORS are made in ratings from 1/1000 to 1/6 H. P. for various applications. If you require a *quiet* motor—engineered for long life—built for *your* application, consult Russell—exclusive manufacturers of BALLENTINE MOTORS. Write for descriptive bulletin.

BALLENTINE



MOTORS

RUSSELL ELECTRIC CO.
358 W. Huron Street, Chicago, Ill.
MANUFACTURERS OF

BALLENTINE MOTORS

JULY, 1945

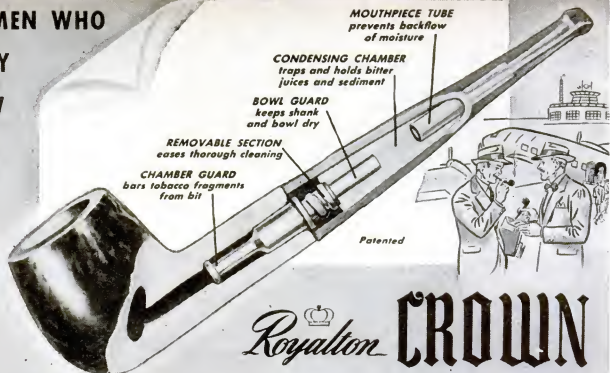
Buy War Savings Bonds and Stamps regularly.

223

**FOR MEN WHO
REALLY
KNOW
PIPES**

\$1.50

Selected
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Royalton CROWN

YOU TASTE ONLY THE SMOKE when your pipe is a Royalton Crown. Bitter juices and slugs are taken into protective custody—permanently trapped by the condensing well and other patented features of this pipe. Its construction, different from all other pipes, keeps bowl and mouthpiece dry and cool . . .
HENRY LEONARD & THOMAS, INC., OZONE PARK 13, N. Y.



Here's one thing you can do while you're waiting for restrictions to be lifted on outboard motors:

Ask the owners of Sea-Horses if they aren't glad they paid a little more—to get the best.

It will be the same after the war. Get a Sea-Horse, even if you have to wait for delivery. You'll never be sorry. Years of extra service and top performance *all* the time, will more than repay you for your wait.

**DO YOUR DUTY —
BUY WAR BONDS**



**JOHNSON
SEA-HORSES**
for DEPENDability

**JOHNSON MOTORS
WAUKEGAN, ILLINOIS**





The "Flying Jeep" has a hundred war jobs — including photo and reconnaissance work, artillery spotting, tank direction, bringing out wounded, and personnel transfer.

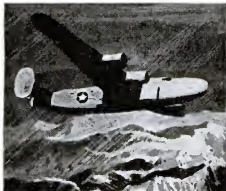


The postwar "Flying Jeep" will have a multitude of light plane uses . . . vacation trips, inter-city travel, for aero-clubs, ranchers, farmers, and surveyors.

Other planes designed and developed by Consolidated Vultee are:



LIBERATOR . . . 4-engine bomber



LIBERATOR EXPRESS . . . transport



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CATALINA . . . patrol bomber



RELIANT . . . navigational trainer



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TWA is one of several leading airlines whose engineers pin their faith on AC—just as do the engineers of 2 out of every 4 cars, trucks and coaches built in America.

During World War I, AC developed the first and only ceramic aircraft plugs for Liberty engines. Constantly improved, these plugs have helped to make aviation history, from Lindbergh's conquest of the Atlantic to the newest records of the Constellation and the C-97. Their war record extends from Berlin to Tokyo. So, too, does that of AC's automotive spark plugs—the kind you use in your car, truck or motor boat.

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION



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Fishhook Holders Formed from Wire and Cork

GUTTED hooks kept on this holder will not become tangled in the tackle box. If three or four are made, all the hooks being used on a single fishing trip can be dropped into the water with a string attached to let the gut soften. Notice how the wire is bent at the top so that the loops of the gut can be quickly attached or detached. Use a large cork and light wire so that if you accidentally drop the holder—and hooks—overboard, the cork will keep it afloat.—R. P. DIERKES.



TWISTED WIRE INSERTED IN BOTTLE CORK

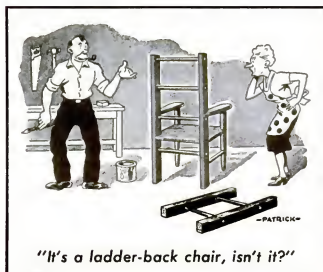
Cylinder Squared for Cutting by Use of Sheet of Paper

CYLINDRICAL objects such as pipes, columns, and the like can be squared true with their sides by wrapping a sheet of paper around them until the ends meet. At least one edge of the paper must be straight.

After the sheet has been wrapped flat against the cylinder, a mark with chalk or pencil along the edge will serve as a cutting guide.—M. LIGOCKI.



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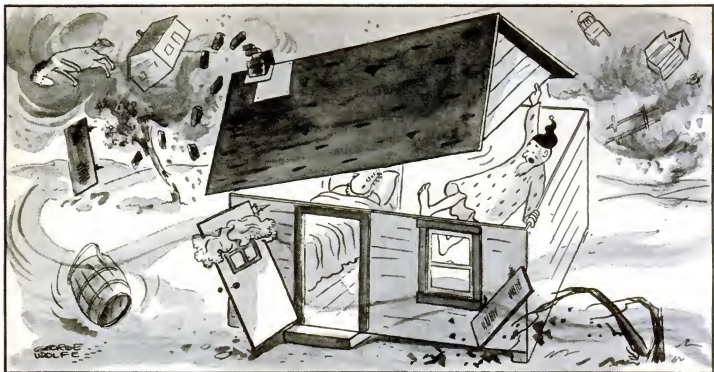
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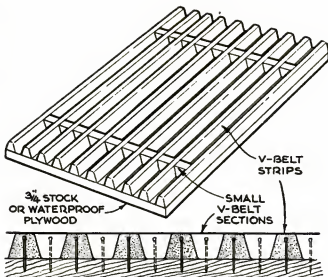
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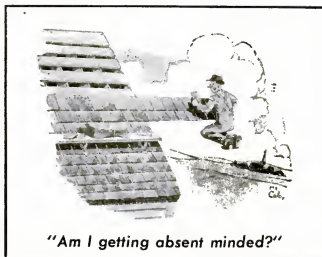
Lengths of Discarded V-Belt Make Unusual Doormat

DISCARDED V-belts can be put to use again as a doormat if you have or can obtain several of them. Cut the belts into strips about 2 ft. long, or place shorter pieces end to end to make up the required length. Use finishing nails to fasten the strips to a piece of $\frac{3}{4}$ " stock or waterproof plywood, as shown above, driving in the heads with a nail set. Separate the strips with inverted sections of belt.—AXEL E. OGREN.



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These are shafts built to run without any "wobbling" which might throw off your measurements.

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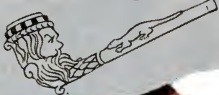
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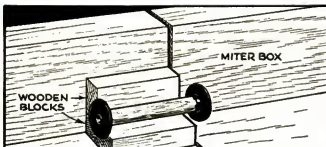
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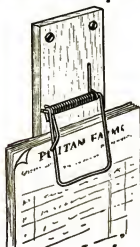
L & H Stern, Inc., Stern Bldg., 56 Pearl St., Bklyn 1, N.Y.

Film Spools Make Good Pulls



HANDLES for light drawers can be made from roll-film spools by sawing across the wooden core about 5/16" from the metal flanges. Two wooden blocks arranged as shown above to hold the spool away from the side and bottom of the miter box will make the cutting easier. A hole already exists in the core to a depth of about 5/16", but the neck of the pull can be made longer than that, of course, by drilling the hole deeper. Fasten the pulls to the drawers with roundhead wood screws or small bolts and nuts.—WILL THOMAS.

Mousetrap Used to Hold Bills



REMOVE the trigger from a new mousetrap and fasten the wooden block to a desk or wall with two brads or screws so that the spring faces downward. It will hold a surprising number of bills and letters. If painted an attractive color, it also can be used on the kitchen wall for grocery bills, recipes, and memos.

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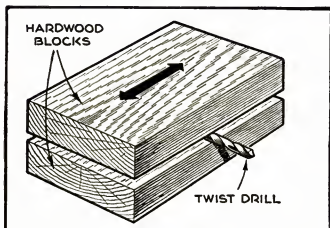
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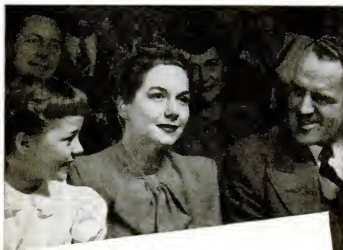
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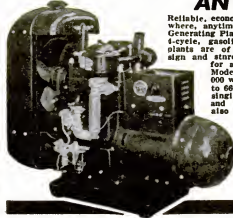


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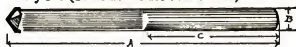
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	3.00	$4\frac{1}{2}$ "	$\frac{7}{64}$ "	$\frac{11}{16}$ "
$\frac{3}{16}$ "	2.75	3"	$\frac{11}{64}$ "	$\frac{11}{16}$ "
	3.00	$4\frac{1}{2}$ "	$\frac{11}{64}$ "	$\frac{11}{16}$ "
$\frac{1}{4}$ "	2.75	4"	$\frac{7}{32}$ "	$\frac{11}{16}$ "
	3.00	6"	$\frac{7}{32}$ "	$\frac{11}{16}$ "
$\frac{5}{16}$ "	3.00	4"	$\frac{1}{4}$ or $\frac{9}{32}$ "	$\frac{11}{16}$ "
	3.25	6"	$\frac{1}{4}$ or $\frac{9}{32}$ "	$\frac{11}{16}$ "
$\frac{3}{8}$ "	3.25	6"	$\frac{1}{4}$ or $\frac{5}{16}$ "	$\frac{11}{16}$ "
	3.50	7"	$\frac{1}{4}$ or $\frac{5}{16}$ "	$\frac{11}{16}$ "
$\frac{7}{16}$ "	3.50	8"	$\frac{1}{4}$ or $\frac{5}{16}$ or $\frac{3}{8}$ "	$\frac{11}{16}$ "
	3.75	8"	$\frac{1}{4}$ or $\frac{5}{16}$ or $\frac{3}{8}$ "	$\frac{11}{16}$ "
$\frac{1}{2}$ "	4.00	8"	$\frac{1}{4}$ or $\frac{5}{16}$ or $\frac{3}{8}$ or $\frac{7}{16}$ "	$\frac{11}{16}$ "
	4.25	8"	$\frac{1}{4}$ or $\frac{5}{16}$ or $\frac{3}{8}$ or $\frac{7}{16}$ "	$\frac{11}{16}$ "
$\frac{9}{16}$ "	4.25	8"	$\frac{3}{8}$ or $\frac{7}{16}$ or $\frac{1}{2}$ "	$\frac{11}{16}$ "

Diameter	Net Price Each	Over-all Length (A)	Diameter SHANK (B)	Length (C)
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	5.00	8"	$\frac{3}{8}$ or $\frac{7}{16}$ or $\frac{1}{2}$ "	2"
$\frac{11}{16}$ "	5.25	8"	$\frac{3}{8}$ or $\frac{7}{16}$ or $\frac{1}{2}$ "	2"
	5.50	8"	$\frac{3}{8}$ or $\frac{7}{16}$ or $\frac{1}{2}$ "	2"
$\frac{3}{4}$ "	6.75	8"	$\frac{7}{16}$ or $\frac{1}{2}$ or $\frac{3}{4}$ "	2"
	6.25	8"	$\frac{1}{2}$ or $\frac{3}{4}$ or $\frac{11}{16}$ "	2"
$\frac{13}{16}$ "	6.50	10"	$\frac{1}{2}$ or $\frac{3}{4}$ or $\frac{11}{16}$ "	2"
	7.00	10"	$\frac{1}{2}$ or $\frac{3}{4}$ or $\frac{11}{16}$ "	2"
$\frac{7}{8}$ "	7.25	10"	$\frac{1}{2}$ or $\frac{3}{4}$ or $\frac{11}{16}$ "	2"
	7.75	8"	$\frac{1}{2}$ or $\frac{3}{4}$ or $\frac{11}{16}$ "	2"
	8.00	10"	$\frac{1}{2}$ or $\frac{3}{4}$ or $\frac{11}{16}$ "	2"
$\frac{15}{16}$ "	9.00	10"	$\frac{1}{2}$ or $\frac{3}{4}$ or $\frac{11}{16}$ "	2"
	9.50	10"	$\frac{1}{2}$ or $\frac{3}{4}$ or $\frac{11}{16}$ "	2"
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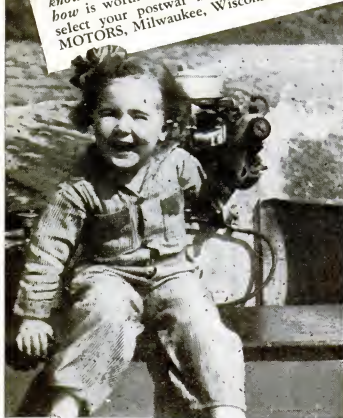
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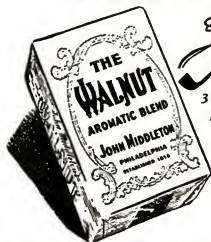
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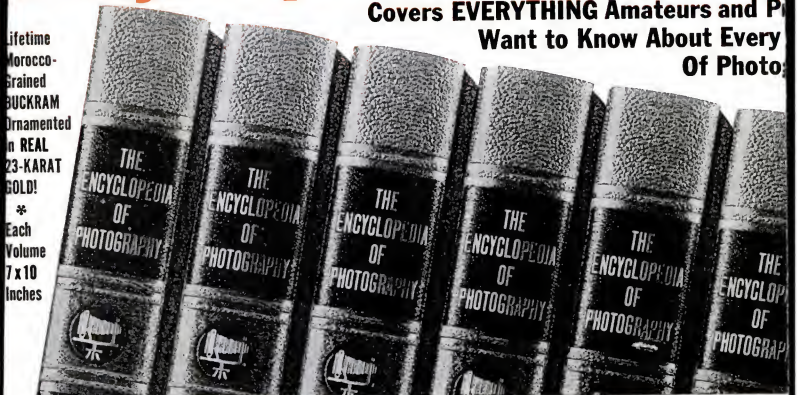
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